

Self and Cross Compatibility in Some Mango Cultivars

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THIS STUDY was carried out during 2013 and 2014 seasons in order to study self and cross compatibility among Sedik, Langra and Ewais cultivars. Sedik, Langra, Hindi, Zebda and Ewais were grown in the farm of horticulture research institute, Giza governorate and used as pollinators. The punicle/inflorescence (%) and fruit set average were recorded in the two seasons. In Sedik the results of punicles/inflorescence (%) and fruit set were the highest when Sedik was self pollinated. Langra, showed best results when Zebda and Hindi was used as pollinators. Ewais punicles/inflorescence (%) recorded its best results when pollinated with Sedik and resulted in the best average of fruit set with Zebda. On the other hand, the factors control punicle/inflorescence% and average fruit set, Anatomical study showed that In Sedik cultivar (stigmas) a few Sedik pollen which could not germinate and the germination was very poor and pollen tube showed abnormal development, they stopped growth early in the style.

In Langra cultivar (stigma) Zebda pollen germination was very poor and the pollen tubes grew very slowly and showed abnormalities which led to an earlier cessation of growth. In Ewais cultivar (stigma) Sedik pollen had poor germination the style tissue was senesced

Thus, it can be concluded that, Sedik, pollinators was suitable for Sedik cultivar, However, Hindi and/or Zebda were suitable as pollinators for Langra cultivar. While Sedik and Zebda were suitable pollinators for Ewais.

Keywords: Mango, Pollination, Compatibility.

Most of mango cultivars have low productivity, due to some reasons *i.e.* the alternate bearing, malformation, lower fruit set and higher fruit drop at different growth stages. Concerning fruit set, it was mainly attributed to the less effective pollination, the limited period of stigmatic and to the protogyny (Spencer and Kennard 1955). Many varieties were found to be self fruitful, but cross pollination seemed to be necessary in order to obtain reasonable crops (Ali and Mazhaar, 1960). Pollination in mango is essential for fruit setting and it is chiefly done by insects (Chandbr, 1958 and Singh, 1960). Natural pollen transfer only initiates fruiting while the stigmas are receptive, that is capable of holding pollen and stimulating germination. The growing pollen tubes take time to affect

fertilization before the senescence of ovules (Williams *et al.*, 1984). After pollen grain is being transferred to the stigma, it starts germination, then pollen tubes penetrate the stigma and grow down through the style until it enters the loculus, and so to the ovules where fertilization takes place. Callus in either living or dead tissue can be stained selectively with water soluble aniline blue which fluoresces in ultra violet light (Currier, 1957). Compatible tubes are the most rapidly growing ones at all temperatures and their rate of growth is accelerated by raising temperature (Modlibowska, 1945). Fruit set depends on pollination, pollen tube growth and viability of ovules which must be fertilized. The viability of embryo sacs and ovules of fruit trees is rather short and may be a limiting factor for fruit set, especially if pollination is delayed (Stosser and Anvari, 1983).

As mentioned by Afify (1933), there are grades of pollen tubes, a) non-germinating pollen, b) short pollen tubes bending upwards, c) tubes growing to about one third of the style length and d) tubes penetrating the full length of the style.

High levels of pollen sterility were found in lettuce plants when immature flower buds were sprayed with Ethrel compared with the untreated (Han and Lee, 1972). The pollen grain tubes on stigmatic surface indicate viability and germinability rather than an incompatibility reaction (Schmadlak, 1965). In self pollination, pollen tubes are classified into 3 sections, characterized by a marked incompatibility reaction on the stigmatic surface, short, twisted and sometimes bifurcated. Those penetrating the stigma had an overall deposit of callose and/or prominent callose plaques. A few tubes penetrated to maximum of 1 or 2 mm down the free styles. Stigma penetration was good with a wide variation in pollen tube callose content, but most pollen tubes had some overall deposit together with prominent plaques. No penetration beyond 1.5-3.5 mm. Entry to the style tube canal and initial growth was similar to that of compatible cross pollination with small; widely spaced callose plaques, though, growth is slower. Penetration ceased in the free styles or upper joint style column (Williams, 1970).

In compatible tubes contained frequent large callose plaques, sometimes continuous deposition of callose along the tubes and obvious terminal plaques. Cessation of growth was often abrupt, almost all tubes penetrating about 6 mm and then stop at the junction into the joint style (Stott, 1972). Fluorescence-microscopic is a method which enables one to determine the viability of ovules at a very early stage (Anvari and Stosser, 1978). In early stages of development; by means of fluorescence microscopic method. The ovaries were stained with aniline blue, it was demonstrated that pollen tubes grew only in ovules which did not show fluorescence. They were not fertilized and must be considered as non viable ovules even cytologically they showed a normal development. The aim of the current work was assessed self and cross compatibility in some mango cultivars.

Materials and Methods

The present work was carried out through two successive seasons 2013 and 2014 at the orchard of horticulture research institute, Giza governorate, Egypt. Mango trees were about 12 years old, grafted on seedlings of local clone and all trees were treated alike in manuring, mineral fertilization, irrigation and pest control. In each season, healthy trees were selected nearly similar in vigour and size to be used for various treatments. In each season, Sedik, Ewais and Langra mango trees (three replicate of five inflorescences for each replicate) were sprayed at the first pink stage of flowers with Ethrel at 25 ppm to induce complete male sterility (Fig. A). The anthers were tested when they did not burst or produce pollen grains.



Fig. A. an strel anther as result of Etherl treatment.

In addition, fifteen inflorescence for each variety were sprayed with distilled water and kept as control. Therefore, the following crosses had been done

Pollinator	Sedik	Zebda	Hindi	Ewais	Langra
Cultivar					
Sedik	X	X	X	X	X
Langra	X	X	X	X	X
Ewais	X	X	X	X	X

Flowers of the five studied pollinators (Ewais, Sedik, Langra, Hindi and Zebda) were collected at the balloon stage and kept on paper sheets for over night at room temperature to encourage anthers dehiscence, part of these pollen grains was taken to investigate the pollen viability using triphenyle tetrazolium chloride (TTC) staining solution. One part of 10% TTC:10 parts of 60% sucrose solution (Oberle and Watson, 1953). The percentage of pollen germination was also recorded. Pollinizers were enclosed in pergamin bags at the end of the full pink stage.

At the pollination times, the previously bagged inflorescences of Ewais, Sedik, Langra, Hindi and Zebda cvs were cut and topped lightly on the emasculated inflorescences of Sedik, Ewais and Langra trees. The pergamin bags were replaced immediately. In order to determine the self and /or cross fertility in Sedik, Ewais and Langra cvs, 15 branches from each cv – were bagged before anthesis and left until petal fall.

Samples of pistils from each cv were taken after 7 days from pollination. Then, they were fixed immediately in E.P.A. (formalin: propionic acid: Ethanol 90:5:5). Samples of pistils were softened in 8N NaOH for 2 hours, washed with tap water for 24 hours and stained in 0.1% aniline blue (w/s), dissolved in 0.1 K₃PO₄ and examined with Lica fluorescence microscope according to the method of Kho and Baer (1970).

When the dissected styles were viewed under the fluorescence microscope (F.M), pollen grain and tubes were readily identified by their brilliant yellow fluorescence, ovule viability was investigated according to Anvari & stosser (1978) and Abou Elnasr & Wanas (1992).

Ovules showing very intensive fluorescence were considered as non viable or senescent. After 3 weeks from pollination, the number of setting fruits per panicle was recorded for each treatment. A complete randomized design was used for each study and the obtained data were statistically analysed according to (Snedecor and Cochran, 1980).

Results and Discussion

Data in Table 1 clearly show that Sedik cultivar receive pollination from it self was better than all other used pollinator cultivars as it recorded 25% of inflorescences succeed to have a fruit sets as compared to 16.7%, 16.7% , 8.3% and 8.3% for Zepda , Ewais, Hindi and Langra pollinators, respectively.

Langra cultivar received pollinating from Zepda and Hindi was better than all other used pollinators. It recorded 58.3% inflorescences have a fruit sets followed by Ewais and Sedik pollinators 50.0% and 41.7%, respectively. Langra self pollination was the worst, it recorded 16.7 of inflorescences having fruits

Ewais cultivar received pollination from Sedik pollinator 50.0% followed by Langra and Hindi pollinator 33.3%. Zebda pollinator was considered as a lower pollinator 8.3% whereas its self pollination was intermediate 25.0% of inflorescences having fruit sets.

In relation to pollinators: Table 1 show that Sedik pollinators recorded best result with Ewais cultivar 50.0% of where inflorescences succeeded to have a fruit sets followed by Langra and its self came at the end. Zebda pollinator gave its best result with Langra only 58.3% of inflorescences succeeded to have a fruit sets and was less with other studied cultivars, Hindi pollinator gave its best result

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with Langra only 58.3% of inflorescences succeeded to have a fruit sets flowed by Ewais cultivars 33.3% of inflorescences succeeded to have a fruit sets and was too few with Sedik 8.3% of inflorescences succeeded to have a fruit sets. Ewais pollinator showed its best results with Langra 50.0 of inflorescences succeeded to have a fruit sets flowed by Ewais it self 25.0 of inflorescences succeeded to have a fruit sets and Sedik 16.7% of inflorescences succeeded to have a fruit sets. Langra pollinator give its best result with Ewais 41.7% of inflorescences succeeded to have a fruit sets and was less with it self 16. 7% of inflorescences succeeded to have a fruit sets and so little with Sedik 8.3% of inflorescences succeeded to have a fruit sets.

TABLE 1. Percent of inflorescence succeed in average number of fruit set.

Pollinator	Sedik			Zebda			Hindi			Ewais			Langra		
Cultivar	2013	2014	AV	2013	2014	AV	2013	2014	AV	2013	2014	AV	2013	2014	AV
Sedik	25.0	25.0	25.0	16.7	16.7	16.7	8.3	8.3	8.3	8.3	25.0	16.7	8.3	8.3	8.3
Langra	50.0	33.3	41.7	50.0	66.7	58.3	50.0	66.7	58.3	58.3	41.7	50.0	25.0	8.3	16.7
Ewais	58.3	41.7	50.0	8.3	8.3	8.3	41.7	25.0	33.3	16.7	33.3	25.0	41.7	25.0	33.3
LSD (A)	First season 15.5			Second season 16.6			A (pollinators) 16.6								
LSD (B)	12.0			12.9			B (cultivars) 12.9								
LSD (AB)	26.8			28.7											

AV= average (mean)

Data in Table 2 clearly show that Sedik cultivar fertility to itself was significant better than the other used pollinator cultivars. It recorded 8.6 fruit sets in inflorescences as compared to 6 , 2.5, 1 and 1 fruit sets inflorescences for Ewais , Zebda, Hindi and Langra, respectively.

The fertility of Langra cultivar when pollinated from Hindi and Zepda was better than all other used pollinators. It recorded 15 and 10.6 fruit sets in inflorescences followed by Sedik 8.6, Zebda 5.5 fruit sets inflorescences and Langra 3 fruit sets inflorescences. Langra self pollination was the worst.

Ewais cultivar fertility to Zebda 55 fruit sets inflorescences followed by Hindi and Langra 24.75 and 23.8 fruit sets, respectively. Ewais self pollination was medium fertile 14.33 fruit sets / inflorescence. Sedik was the worst 8 fruit sets / inflorescence.

In relation to pollinators, Sedik showed regular results with all studied cultivars, it showed 8, 8.6 fruit sets / inflorescence and 8 fruit sets / inflorescence for Sedik, Langra and Ewais, respectively.

Zebda pollinator gave its best result with Ewais only 55 fruit sets / inflorescence and was less with other studied cultivars, Hindi pollinator gave its

best result with Ewais only 24.75 fruit sets / inflorescence flowed by Langra cultivars 15 fruit sets and was so less with Sedik 1 fruit sets / inflorescence.

Ewais pollinator showed its best results with it self 14.33 fruit sets / inflorescence followed by Langra and Sedik 10.66 and 6 fruit sets / inflorescence respectively. Langra pollinator gave its best result with Ewais 23.8 fruit sets / inflorescence and was less with it self 3 fruit sets and so little with Sedik 1 fruit sets / inflorescence.

TABLE 2. Effect of pollinators and pollinated mango cultivar on Average number of fruit set in cluster.

Pollinator	Sedik			Zebda			Hindy			Ewais			Langra		
Cultivar	13	14	AV	13	14	AV	13	14	AV	13	14	AV	13	14	AV
Sedik	10.0	6.0	8.0	1.0	4	2.5	1.0	1.0	1.0	5.0	7.0	6.0	1.0	1.0	1.0
Langra	10.0	7.2	8.6	6.0	5.0	5.5	10.0	20.0	15.0	10.0	11.4	10.7	4.0	2.0	3.0
Ewais	7.0	9.0	8.0	40	70	55	22.0	27.5	24.75	12.0	16.6	14.3	27.6	20.0	23.8
LSD (A)	First season			Second season			A (pollinators) B (cultivars)								
LSD (B)	7.0			5.0											
LSD (AB)	5.5			11.3											
	12.3														

AV= average (mean)

These results agreed with that obtained by Hesse (1976), who stated that Durado cv is considered self-unfruitful as well as Santa-rosa cv which appeared to be cross-unfruitful with Durado cv. Kloppers and Hadlow (1976), they found that Eldorado cv was good pollinator for santa-rosa cv. Carvalho and Raseira (1992) noted that santa-rosa cv seemed to be self unfruitful.

Pollen viability

Data presented in Table 3 show pollen viability of Sedik, Zebda, Hindy, Ewais and Langra mango cvs. Results indicated that Ewais cultivar had the highest rate of pollen viability in comparison with other cultivars (72.4%) followed by Sedik (36.3%) then Zebda (23.0%) while this percentage in Hindy cv was (12.8%). Such results are in harmony with the findings of (Dahshan, 1971) who reported that viability of pollen grains differs according to the time of inflorescence emergence and its position on panicle. He found that pollen grain viability of Zebda cv was 70% while this percentage in Taimour cv was (35%) in early inflorescence and increased to 65% in normal and 74% in late inflorescence, he added that the viability of pollen grain in both cvs were higher in terminal parts of inflorescences but decreased towards the basal parts. In addition Lee (1980) found that the germination rate in vivo of some plum cvs varied considerably from one year to other and the rate was higher in vivo than in vitro (ranging from 32% to 96%). Also Bozhkova (1995) classified pollen germination of *prunus cerasifera* varities into four gropes; low (up to 42%), moderate (43-62%, high (63-81%) and very high (over 81%).

TABLE 3. Percentage of pollen viability of the studied mango cultivars.

Sedik	Zebda	Hindy	Ewais	Langra	L.S.D
36.3	23.0	12.8	72.4	14.3	5.2

Anatomical study

Compatibility and/or incompatibility between the studied mango cultivars:

Pollen tubes characteristics in Ewais style after. Pollination with different pollen donors (Fig. 1).

- A) Ewais X Sedik: The germination of pollen was poor on Ewais stigma and the style tissue senesced after 7 days from pollination
- B) Ewais X Langra: With Langra pollen grains: a lot of pollen could arrive to the stigma of Ewais, but could not germinate.
- c) Ewais selfing: microscopic examination revealed that most of pollen grains could not arrive the stigma and there is a varying degrees of self incompatibility.
- d) Ewais X Hindi: when Ewais mango flowers were pollinated with Hindi pollens most of the pollen grains germinated on the stigma surface and its growth visible in the upper part of the style but they could not reach the ovary. The microscopic examination in this combination revealed varying degrees of cross incompatibility characteristics.
- e) Ewais X Zebda: poor pollen grain arrive to the stigma and there is a senescence in the tissue after 7 days from pollination. Lee (1980) found that pollen tube growth was positively correlated with the amount of pollen on the stigma. A positive correlation was found between rate of pollen germination in vitro and pollen tube growth in the style.

Generally, it could be said that Ewais cv is considered as self-incompatible, whereas, Sedik, Langra, Hindi and Zebda are considered as partially cross-incompatible for Ewais cultivar.

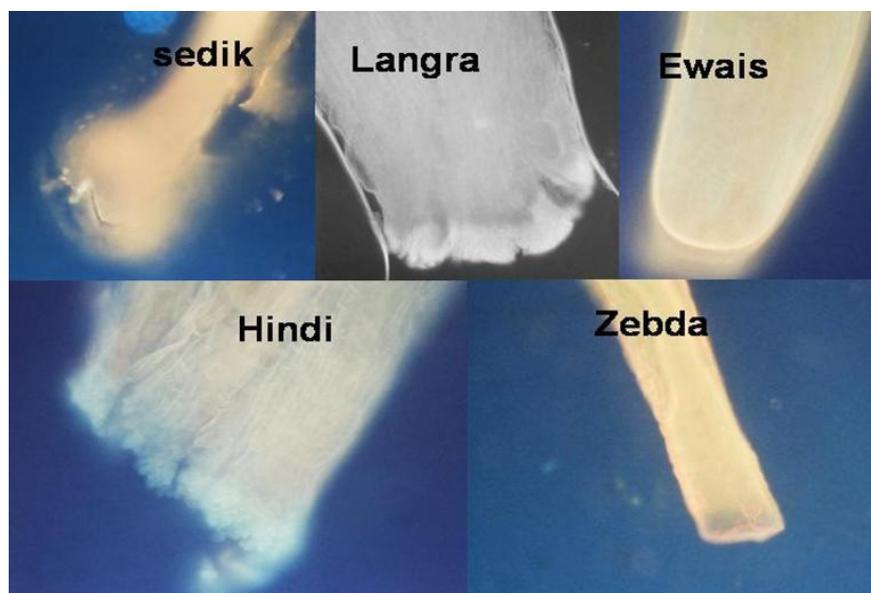


Fig. 1. Sedik, Langra, Ewais, Hindi and Zebda mango pollen grains germination on Ewais mango flowers stigmas.

Pollen tubes characteristics in Langra style after cross pollination with different donors (Fig. 2).

- A) Langra (selfing): a little number of Langra pollen grain could arrive the stigma of Langra flowers. The pollen tube grows very slowly in the style. The microscopic examination in this combination revealed varying degrees of self incompatibility.
- B) Langra X Sedik : there was a little number of germinated pollen on the stigma surface of Langra cv. But produced short pollen tubes with plugs which was unable to penetrate the stigma. Stott (1972), Stosser & Anvari (1982), Abou El-Nasr (1987) and Brain *et al.* (1989) reported that, incompatible tubes continuous depositions. Along the tubes and obvious terminal plugs.
- C) Langra X Zebda: The germination of pollen was very poor and the pollen tubes grew very slowly and stopped its growth early. Pollen tubes of Zebda showed abnormalities which led to stopping their growth.
- D) Langra X Hindi: illustrated presence of distorted pollen tubes, short tubes which were unable to penetrate the stigma as well as swelling tube tips. Partial cross incompatibility was observed when Langra flowers were pollinated with Hindy pollens.
- E) Langra X Ewais: show that the surface of the stigma of Langra cv is empty from pollen germination, this means that Ewais cv is partial cross incompatibility for Langra.

Generally, it could be said that Langra cv. could be considered as self-incompatible, whereas Sedik, Zebda, Hindi and Ewais are considered as partially cross incompatible for Langra cv.



Fig. 2. Sedik, Langra, Ewais, Hindi and Zebda mango pollen grains germination on Langra mango flowers stigmas.

Pollen tube characteristics in Sedik style after cross-pollination with different pollen donors (Fig. 3).

- A) Sedik X Langra: Most of pollen grains germinated on the stigma surface and pollen tubes were visible in the upper part of the style and grew to about 1/3 of the style length then stopped. However, some of pollen tubes showed abnormal growth.
- B) Sedik X Hindi: Microscopic examination revealed that there is deposition of cullose along the tube. Terminal cullose plugs were present in most of pollen tubes, which indicated pollen tube incompatibility.
- C) Sedik X Sedik (selfing): In this combination the stigma has a few pollen grains which could not germinate. The germinated pollen of Sedik cv was very poor on the stigma. Pollen tube showed abnormal development, they stopped its growth early in the style.
- C) Sedik X Zebda: Microscopic examination in this combination revealed that pollen tubes of Zebda cv grew in the style of Sedik cv with different rates and failed to reach the end of the style.
- D) Sedik X Ewais: In this combination most of pollen grains germinated on the stigma surface, its growth reached about 2/3 length of the style then stopped. In addition, microscopic examination revealed varying degrees of cross-incompatibility.

Generally, it could be said that Sedik as a female parent seemed to be partially cross-incompatible with different pollen donors (Langra, Hindi, Zebda and Ewais). In addition Sedik cv seems to be self-compatible.

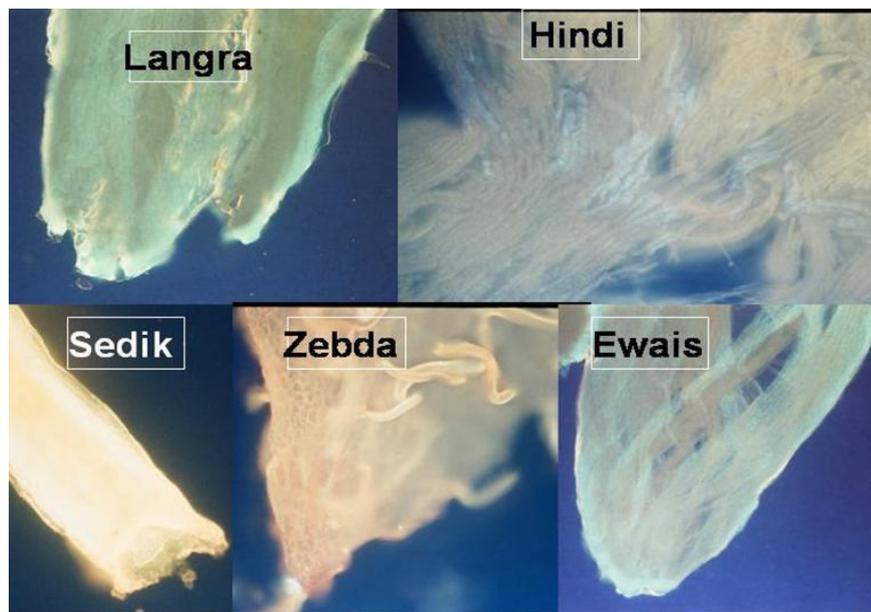


Fig. 3. Sedik, Langra, Ewais, Hindi and Zebda mango pollen grains germination on Sedik mango flowers stigmas.

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التوافق الذاتي والخلطي لبعض أصناف المانجو

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قسم بحوث الفاكهة الاستوائية - معهد بحوث البساتين - مركز البحوث الزراعيه - القاهرة - مصر.

أجريت هذه الدراسة ما بين موسمي ٢٠١٣ و ٢٠١٤ لدراسة التوافق الذاتي والخلطي لأصناف صديق - لانجرا - العويس كأصناف أم مع الأصناف صديق - لانجرا - هندي - زبدة - عويس كملقحات أجريت هذه الدراسة في مزرعة معهد بحوث البساتين - الجيزة - مصر - متوسط النتائج خلال موسمي الدراسة لنسبة الشماريخ التي بها عقد (عناقيد الثمار) / النورات % ونسبة العقد في النورة سجلت في الصنف الصديق نسبة عناقيد الثمار / النورات % ونسبة العقد في النورة سجلت أفضل النتائج مع الصديق (الملقح) تلقح ذاتي، بينما سجل الصنف لانجرا أفضل النتائج مع ملقحي الزبدة والهندي. الصنف العويس سجل أفضل نسبة عناقيد ثمار مع الصديق بينما سجل أفضل عقد داخل النورة مع الصنف زبدة خلال موسمي الدراسة.

أما بالنسبة للعوامل التي تحكمت في نسبة العقد الدراسة التشريرية أثبتت أن القليل من حبوب اللقاح إلى الصنف الصديق عندما تصل إلى ميسم أزهار الصنف الصديق لا تثبت والقليل جدا الذي يثبت ينتج أنابيب لقاح نموها غير طبيعي وتتوقف ميكراً في القلم.

أما علي مياسم أزهار الصنف لانجرا وصول حبوب اللقاح الزبدة إليه كان قليل جدا ونمو الأنابيب كان بطيئاً وغير طبيعي مما أدى إلى توقف نموها مبكراً. في مياسم أزهار الصنف عويس أظهرت إنبات شحيح لحبوب اللقاح الصنف الصديق وتحللت أنسجة القلم (مما يعنى توقف العملية قبل الإخصاب).

من خلال هذه الدراسة يمكن التوصية باستخدام الصنف صديق كملقح للصنف صديق، بينما يستخدم الزبدة او الهندي كملقح للصنف لانجرا ويستخدم الصنف زبدة كملقح للعويس.