Floral biology of kerstings groundnut (*Kerstingiella geocarpa* Harms)

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SUMMARY

Floral biological studies of three varieties of kerstings groundnut (*Kerstingiella geocarpa* Harms) were conducted at the glasshouse of University of Nigeria, Nsukka, during 1988 and 1989. Two seeds of each variety were sown in 28 cm polythene pots fertilized at 0.371, 0.474 and 0.142 grams of urea, single superphosphate and muriate of potash respectively per pot. The experiment was laid out as a completely randomized design with four replications. NSK 2 variety was classified as *early* whereas NSK 1 and "Ex-Mali" were classified as *late* varieties with respect to days to flower bud emergence, first flower, 100 per cent flowering and flowering duration. The duration from flower bud emergence to anthesis were 5.5, 6 and 6.5 days in NSK 2, Ex-Mali and NSK 1 respectively. The late varieties produced higher seed yield compared to the early variety, but the differences were not significant. There was a positive and significant correlation (r=0.999) between duration from flower bud emergence to anthesis and seed yield indicating that seed yield can be adequately predicted when this duration is known. Flowering duration varied from 22 days in the early variety to 31 and 33 days in the late varieties with peak period of anthesis occurring in both varieties between 12 h and 14 h. Anthesis in the morning was late (between 6.10 a.m. and 7.15 a.m.) in the *early* variety and early (between 5.30 a.m. and 6.00 a.m.) in the *late* varieties. Flowers closed in all varieties between 5.30 p.m. and 9.30 p.m. Dehiscence of anthers started 7-8 h before anthesis. Longevity of viable pollen grains was more when preserved at lower temperature and relative humidity than under room temperature and relative humidity. Pollen fertility was high in all the varieties. The stigma became receptive to viable pollen in the three varieties from 12 h before anthesis and up to 6 h after.

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RÉSUMÉ

OBASI, M. O. & EZEDINMA, F. O. C. : *La biologie florale de l'arachide kerstings (*Kerstingiella geocarpa *Harms).* Les études florales biologique de trois variétés de l'arachide kerstings *(Kerstingiella geocarpa* Harms) se sont déroulées à la serre d' Université du Nigéria à Nsukka en 1988 et 1989. Deux graines de chaque variété étaient semées dans les sacs en plastique fécondés avec 0.371, 0.474 et 0.142 grammes d'urée, de superphosphate seul et de chlorure respectivement par sac. L'expérience a été conçu comme un dessein de quatre reproduction par mitose, exclusivement choisi au hasard. La variété NSK 2 était classifiée précoce, alors que les variétés NSK et Ex-Mali étaient classifiées tardives, surtout en ce qui concerne les nombres de jours de: l'apparition du bourgeon de la fleur, la première fleur, 100 pour cent de floraison et la durée de la floraison. Les périodes entre l'apparition du bourgeon de la fleur et l'anthésis étaient: 5.5, 6.0 et 6.5 jours respectivement en NSK 2, Ex-Mali et NSK 1. Les variétés tardives ont donnés de meilleur rendement en comparaison avec les variétés précoces, mais les différences n'étaient pas significatives. Il y avait une corrélation (r=0.99) positive et significative entre la période de l'apparition du bourgeon de fleur à l'anthésis et le rendement de graine montrant que le rendement de graine pourrait être prévu avec précision, lorsque la durée est connue. La durée de la floraison varie de 22 jours dans la variété précoce à 31 et 33 jours dans les variétés tardives, avec la période de pointe de l'anthésis se produisant dans les deux variétés entre 12 et 14 h. Anthésis de la matinée était tard (entre 6.10 et 7.15 h) dans la variété précoce et tôt (entre 5.30 et 6.00 h) dans les variétés tardives. Dans toutes les variétés les fleurs se sont fermées entre 17 h:30 et 21 h: 30. La déhiscence d'anthères a commencé de 7 à 8 h avant athesis. La longévité de grains de pollen viable était davantage lorsqu'ls sent préservés à une température et humidite relative inférieures par rapport à une humidite relative et une température ambiante. La fétilité de pollen était supérieure dans toutes les variétés. Le stigmate est devenu réceptif au pollen viable dans les trois variétés, de 12 h avant l'anthésis jusqu' à 6 h aprés.

Introduction

Production of edible vegetable protein is falling rapidly in Nigeria partly due to an appreciable decline in the cultivation of cowpea (*Vigna unguiculata* (L.) Walp), soybean (*Glycine max.* (L.) Merr.) and pigeon pea (*Cajanus cajan* (L.) Millsp.), the three main local sources of vegetable protein in the country. This decline has been attributed to the increasingly high cost of production of cowpea, soybean and pigeon pea (Ogundipe & Osho, 1990). Future increase in edible vegetable protein production may be achieved partly through the introduction and large-scale production of additional sources of cheap vegetable protein crops.

Kerstings groundnut or groundbean (*Kerstingiella geocarpa Harms.*; syn *Macrotyloma geocarpa* Harms., Marechal & Baudet) is one of such promising crops, often described as high quality protein crop for the tropics, (Duke, Okigbo & Reed, 1977). The search for alternative sources of consumption of kerstings groundnut in most households when the price of cowpeas become prohibitive. It is, therefore, probable that adoption and large-scale production of kerstings groundnut will improve vegetable protein production in the country.

Hepper (1963) identified kerstings groundnut as under-exploited protein-rich leguminous crop indigenous and adapted to the humid tropics. Obasi & Ezedinma (1991) noted that kerstings groundnut has significant potential as a source of human diet since the high contents of protein, carbohydrate, crude fibre and calories in the seeds, pods and leaves encourage attempts to breed varieties with greater amounts. In the chemical composition of kerstings groundnut, cowpea and soybean (Obasi & Ezedinma, 1991), protein (%) in seeds was the least in variety NSK 2 (19.2 %) and the highest in variety NSK 1 (24.7 %) followed by Ex-Mali variety (22.8 %) of kerstings groundnut. These varieties have comparable protein to cowpea seeds (22.9 %), but lower than that of soybean (38.0 %).

Smart (1976) noted that kerstings groundnut has high contents of essential sulphur amino acids (mg/g N) namely, cystine 63 and methionine 86, which indicate the possibility of obtaining high quality protein in the diet especially when eaten in combination with high lysine maize (*Zea mays*). Maize cooked with kerstings groundnut is a highly-relished food in West Africa particularly in Mali, Burkina Faso, Benin and southern Nigeria where this legume is an important crop. Generally, kerstings groundnut is eaten boiled or ground into a paste for making *moi-moi* (steamed paste), *akara* (fried paste) similar to other grain legumes, such as cowpeas.

Adequate knowledge of floral biology is a prerequisite for overcoming morphological and genetic barriers to successful hybridization in kerstings groundnut. This vital information is not well known to plant breeders and geneticists who often fail in their attempts to cross varieties. Thus, the primary limitation to the improvement of this crop still remains unabated. For example, the exact cause of high rate of flower abscission which constitutes a major source of yield erosion in kerstings groundnut is not yet known (Obasi, 1989). In order to facilitate the progress of breeding programmes, a detailed study of various aspects of floral biology of the crop is presented in this paper.

Materials and methods

Cultivated varieties of kerstings groundnut namely NSK 1, NSK 2 and Ex-Mali were studied for commencement and period of flowering, anthesis, dehiscence of anthers, morphology, viability and longevity of pollen grains and stigma receptivity. The studies were conducted at the glasshouse of University of Nigeria Teaching and Research Farm, Nsukka (Latitude 6° 52'N; at 400 m above sea level). Two seeds of each variety were sown on July 23 in 1988 and 1989 in 28 cm radius black polythene pots filled with sterilized soil. Fertilizer at 0.371, 0.474 and 0.142 g of urea, single superphosphate and muriate of potash per pot equivalent to 40 N, 20 P_2O_5 and 20 K_2O kg/ha respectively were mixed with the soil in each pot. Five days after emergence, the seedlings were thinned to one per pot. Each of the three varieties were assigned to 8 pots and replicated 4 times. The study was laid out in a completely randomized design.

Longevity of pollen viability was determined by germinating pollen grains in artificial media according to the techniques of Oak (1958) and Vasil (1962). Acetocarmine staining test was also used to determine fertile and sterile pollen grains. The size of pollen grains was determined by measuring at × 400 magnification. From NSK 2, NSK 1 and Ex-Mali varieties, 80 flowers in each were collected immediately after the anthers dehisced but not shed and were preserved at (a) room temperature (27.5 °C) and relative humidity of 93 per cent in glass vials plugged with cotton wool; (b) in glass vials over anhydrous calcium chloride in a sealed dessicator and refrigerated at 10 °C and 0 per cent relative humidity. Pollen germination tests were carried out in 2.5, 5.0, 7.5, 10.0, 12.5 and 15.0 per cent sucrose solution to which 0.01 per cent boric acid was added. Stigma receptivity was tested by artificial pollen germination on the stigmatic surface.

TABLE 1

Bud and Flower Development in Three Varieties of Kerstings Groundnut at Nsukka, Nigeria in 1988 and 1989

Varieties	Days to			
	bud emergence	*anthesis*	*100 per cent flowering*	*Flowering duration (days)*
NSK 1	45.0	51.5	58.0	33.0
NNSK 2	38.5	44.0	48.0	22.0
Ex-Mali	46.0	52.0	58.0	31.0
Mean	43.2	49.2	54.7	28.7
CV %	6.9	5.7	8.6	10.4
F-LSD (P=0.05)	3.18	2.93	4.01	2.67

Results and discussion

Days to flower bud emergence, first flower opening, 100 per cent flowering and duration of flowering were significantly (P<0.05) earlier in NSK 2 than NSK1 and Ex-Mali varieties (Table 1). Results summarized in Table 2 show that duration from flower bud emergence to anthesis were 6 and 6.5 days in Ex-Mali and NSK 1 varieties respectively, being longer compared to 5.5 days in NSK 2 variety, though the differences were not significant. Similarly, duration from flower bud emergence to 100 per cent flowering were significantly (P<0.05) delayed in NSK 1 (13 days) and Ex-Mali (12 days), being earlier in NSK 2 (9.5 days). Seed yield did not differ significantly and was 8.5 g/plant produced by NSK 2 which was lower than 9.6 g/plant and 10.8 g/plant produced by Ex-Mali and NSK 1 varieties, respectively. There was a positive and significant (P<0.05) correlation (r=0.999) between duration from flower bud emergence to anthesis and seed yield. Similar observation was made by Nath & Randhawa (1959) who reported positive and significant correlation between duration of flower bud development and yield of pomegranate (*Punica granatum* L.). The present result indicates that seed yield (Y) can be adequately predicted if the duration from flower bud emergence to anthesis (X) is known. The response equation is given by

$$Y = -4.1667 + 2.3000X;\ r^2 = 0.998$$

Variety NSK 2 flowered in 44 days and was classified as *early* variety. NSK 1 and Ex-Mali

TABLE 2

Duration from Flower Bud Emergence to Anthesis and 100 per cent Flowering and Seed Yield in Three Varieties of Kerstings Groundnut at Nsukka, Nigeria in 1988 and 1989

Varieties	Days from bud emergence to		Seed yield (g/plant)
	anthesis	*100 percent flowering*	
NSK 1	6.5	13.0	10.8
NSK 2	5.5	9.5	8.5
Ex-Mali	6.0	12.0	9.6
Mean	6.0	11.5	9.6
CV (%)	1.8	5.2	2.5
F-LSD (P=0.05)	NS	1.08	NS

flowered in 51.5 and 52 days respectively and were classed *late* varieties. The *early* variety NSK 2 had a shorter flowering duration (22 days) while flowering was longer in the *late* varieties (31 days for Ex-Mali and 33 days for NSK 1).

There was a difference in the time of anthesis in the three varieties. The flowers of NSK 2 started opening between 6.10 a.m. and 7.15 a.m. and those of NSK 1 and Ex-Mali between 5.30 a.m. and 6.00 a.m. The process of opening of corolla took 45 to 55 min. The corolla remained open for 10 - 12 h. The flowers started closing from 5.30 p.m. and were completely closed by 9.30 p.m. The effect of time on anthesis per cent is diagramatically shown in Fig. 1. Peak anthesis was observed between 1200 and 1400 h in the three varieties and, thereafter, it declined (Table 3). Mature anthers started dehisc-

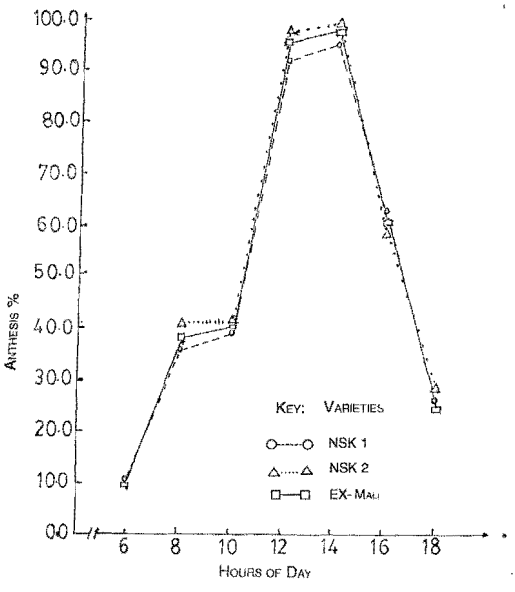

Fig. 1. Effect of time (hours) on anthesis (per cent) in three varieties of kerstings groundnut

TABLE 3

Anthesis in Three Varieties of Kerstings Groundnut at Nsukka, Nigeria in 1988 and 1989

	Percentage of anthesis at hours						
Varieties	*06*	*08*	*10*	*12*	*14*	*16*	*18*
NSK 1	10.1	35.6	39.0	92.1	95.2	63.0	26.1
NSK 2	0.0	40.7	41.0	98.0	98.8	59.0	29.0
Ex-Mali	9.8	38.0	40.0	96.0	98.2	61.0	25.2

TABLE 4

Size and Fertility of Pollen Grains in Three Varieties of Kerstings Groundnut at Nsukka, Nigeria in 1988 and 1989

Varieties	*Size of pollen grains*		*Proportion of fertile pollen (per cent)*
	Range μ	*Mean μ*	
NSK 1	6 - 8	7	87.6
NSK 2	9 - 11	10	89.5
Ex-Mali	6 - 8	7	88.0

ing about 7-8 h before anthesis. Mature pollen from freshly dehisced anthers collected at 12 noon from the three varieties was successfully germinated in different concentrations of sucrose. But 12.5 per cent solution of sucrose gave the best per cent germination. Pollen remained viable for 45 h at room temperature (27.5 °C) and relative humidity of 93 per cent. When preserved in a refrigerator at 10 °C and 0 per cent relative humidity, the period of pollen viability increased to 72 h.

In the three varieties, pollen grains appeared oblong in the dry state but became spherical in wet conditions. The pollen grains had an average size of 10 μ in NSK 2 and 7 μ in NSK 1 and Ex-Mali (Table 4). A count of the acetocarmine treated pollen grains show that fertility of pollen grains was high in all the varieties (Table 4), though it tended to be higher in NSK 2 compared to Ex-Mali and NSK 1. The stigma became receptive to pollen in the three varieties from 12 h before anthesis and remained so up to 6 h after. Thus, the whole period of receptivity of the stigma was 18 h.

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REFERENCES

Duke, J. A., Okigbo, B. N. & Reed, C. F. (1977) Underexploited legumes: Kerstings groundnut *Macrotyloma geocarpa* Harms., Marechal & Baudet). *Trop. Grain Legume Bull.* **10**, 12-13.

Hepper, F. N. (1963) Plants of the 1957-58 West African expedition: The bambara groundnut (*Vigna subterranea*) and kerstings groundnut *Kerstingiella geocarpa*) wild in West Africa. *Kew Bull.* **16**, 395-407.

Nath, N. & Randhawa, G. S. (1959) Studies on floral biology in pomegranate (*Punica granatum* L.). *Indian J. Hort.* **16**, 61-68.

Oak, A. J. (1958) Pollen behaviour in peanut. *Agron. J.* **52**, 387-389.

Obasi, M. O. (1989) Some studies on growth, development and yield of kerstings groundnut (*Kerstingiella geocarpa* Harms.) in a derived savanna environment of southern Nigeria, 375 pp. (Ph.D. Thesis) University of Nigeria, Nsukka.

Obasi, M. O. & Ezedinma, F. O. C. (1991) Evaluation of growth and chemical composition in kerstings groundnut (*Kerstingiella geocarpa*). *Indian J. Agric. Sci.* **61**, 811-814.

Ogundipe, H. O. & Osho, S. M. (1990) Development and introduction of improved soybean utilization technology for use in households and small scale processing enterprises in rural Nigeria. *Final Report of IITA/IAR & T & IDRC Soybean Utilization Project 1987-1990,* 172pp.

Smart, J. (1976) Kerstingiella Harms. Tropical pulses, pp. 60-61. London: Longman Group Limited.

Vasil, I. K. (1962) Studies on pollen storage of some crop plants. *Indian J. bot. Soc.* **41**, 178-s196.