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Floral biology of onion construed as an annual crop for seed production

C Karak and P Hazra

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Abstract : Floral biology of onion was studied employing 14 genotypes grown as annual crop for seed production in which bulbs were produced by transplanting the seedlings during first week of September, harvesting prematurely during last week of December, curing subsequently for 4 days and replanting the bulbs without storage during 29-30 December in open field condition. All the genotypes behaved as short-day tropical type in which flowering stalks were induced even at 25.35°/ 11.74°C day/ night temperature during last week of December to last week of January. All the eleven floral characters varied significantly among the genotypes. Days required from replanting of the bulb to initiation of scape ranged between 33.12 to 41.67 days. Days required from scape initiation to opening of first flower in the umbel ranged between 26.22 to 32.47 days and it took 26.22 to 32.66 days from opening of first to last flower in the umbel. Dichogamous self-pollination control mechanism in the bisexual flowers of onion was manifested by differential maturity of the style and filaments at anthesis, the average length of the style (1.43 mm) being half of that of the filament (3.10 mm) at anthesis. It took on an average 4.75 days for the style to mature and become of the same size as that of filament to reach the vicinity of its own pollens in the anthers. Pollen grains which were small and more or less oblong to oval in shape showed both high viability and germinability with significant variation among the genotypes. The germinating liquid containing 20% sucrose + 0.025% of boric acid was found adequate for *in vitro* pollen germination.

Key words : Floral biology, Onion, Seed Production

Introduction

Onion is one of the important vegetable crops grown in the country in large areas both for local consumption as well as for export purposes. India ranks second in area and production in the world after China and third in export after Netherlands and Spain. Seed production is the pre requisite for both varietal development and its expansion through multiplication of the selected genetic materials. Study on the manifestation of different reproductive features depicting the floral biology of the crop is essential not only to frame seed production programme but also to manipulate the pollination mechanisms of the crop. However, very limited information is available in India on this important aspect of onion. Hence, the present investigation was undertaken employing 14 varieties as an annual crop for seed production to study floral biology of onion.

Materials and methods

The experiments were conducted in two consecutive years (2009-2010 and 2010-2011) at the Central Research Farm, Gayeshpur, Bidhan Chandra Krishi Viswavidyalaya, West Bengal situated at 22°57N latitude and 88°20E longitude with an average altitude of 9.75 m above the mean sea level. In this study, 14 varieties of onion were used, 13 of which were collected from Project Directorate of Onion and Garlic Research, Pune (*viz* Phule Safed, Pusa Red, N-53, Arka Kalyan, Gujarat White, Arka Pragati, Agrifound Rose, Agrifound Dark Red, Fursangi Local, Phule Samarth, Baswant-780, Nasik Red & Agrifound Light Red) and evaluated along with "Sukhsagar", the popular and adaptable cultivar of West Bengal.

The varietal evaluation for their seed production potential was done in a randomized block design with 3 replications following a new method in which the bulbs were produced by transplanting the seedlings during first week of September, harvesting them prematurely during last week of December, curing subsequently for 4 days and replanting without storage during 29-30 December in open field condition. The crop which is basically biennial in nature, thus, could be considered as an annual crop with regard to seed production. Twenty selected bulbs per replication in each of the 14 varieties were re-planted after having soaked in 0.25% solution of mancozeb for

C Karak and P Hazra
Department of Vegetable Crops, Bidhan Chandra KrishiViswavidyalaya, Mohanpur, West Bengal-741252

30 minutes in the well prepared 2.5 m x 2.0 m plot in 4 rows of 5 bulbs with 50 x 50 cm spacing. Average temperature exposure from last week of December to last week of January for induction of flowering was 18.55°C, the average day/night temperature being 25.35°/11.74°C.

Five random plants per replication (plot) were selected for recording data on different floral characters of the crop viz., days to initiation of scape, scape initiation to opening of first flower in umbel, opening of first to last flower in umbel, length of filament at anthesis (cm), anther length at anthesis (cm), style length at anthesis (cm), days required for the style to become the same size as of the filament, pollen diameter (micron), pollen viability (%), pollen germinability (%) and pollen tube length (micron).

Fifty opened flowers (ten per umbel) from 5 selected plants per replication in a span of 25 days were sampled to record length of filament at anthesis (cm), anther length at anthesis (cm), style length at anthesis (cm) and then averaged. Mixed pollens from the anthers of the sampled flowers per replication were used to record pollen viability (%) by 1% acetocarmin staining on a slide and pollen germinability (%) using the germinating liquid containing 20% sucrose + 0.025% boric acid at 25° C temperature under bright light for 4 hours on grooved slide. The slides, three each per replication were viewed in 5 fields of vision in each slide under the compound microscope. The germinated pollens showed clear pollen tube growth. Such pollens counted from five microscopic fields and percentages of germinated pollens were calculated out of total pollens viewed. Length of pollen tubes was measured in all the germinated pollens with the help of ocular and stage micrometer and then averaged.

Twenty five opened flowers (five per umbel) from 5 selected plants per replication in a span of 25 days were tagged with fine red string to record days required for the style to become the same size of the filament. Data recorded for 11floral characters in two years were averaged and used for analysis of variance following Gomez and Gomez (1984).

Results and discussion

Analysis of variance for different floral characters clearly indicated significant differences among the varieties for all the characters (Table 1). Finding of Aklilu and Kataria (2003) that both seed yield potential and seed quality of the tropically adapted onion genotypes were greatly affected by cultivar differences is in line of the present findings.

Table 1. Analysis of variance for different floral characters

Character	Mean sum of squares	
	Genotype	Error
Days to initiation of scape	29.02**	0.32
Days from scape initiation to opening of first flower in umbel	11.42**	0.26
Days from opening of first to last flower in umbel	11.28**	0.75
Length of filament at anthesis (cm)	10.30**	0.06
Anther length at anthesis (cm)	0.59**	0.13
Style length at anthesis (cm)	0.05**	0.04
Days required for the style to become the same size of the filament	1.90**	0.32
Pollen diameter (micron)	1.97**	0.18
Pollen viability (%)	66.06**	1.37
Pollen germinability (%)	155.21**	2.82
Pollen tube length (micron)	295.41**	6.05

** Significant at 1% level

Initiation of scape and flower opening

Flower induction in onion is sensitive to temperature, photoperiod, number of leaves and bulb development. The reproductive response (flowering percentage and date, number of flower stalks and seed production) of onion plants was markedly affected by photothermal conditions (Branca and Ruggeri, 1994). In the present investigation, all the genotypes behaved as short-day tropical type in which flowering stalks were induced even at 25.35°/11.74°C of day/night temperature during last week of December to last week of January. Days required from replanting of the bulb to initiation of scape varied widely among the varieties which ranged between 33.12 days in Agrifound Dark Red to 41.67 days in Sukhsagar (Table 2). Flowers in the umbel were enclosed in a membranous sheath called spathe and the sheath splits because of the pressure created by the growing flowers inside the umbel. The days required from scape initiation to opening of first flower splitting the sheath in the umbel ranged between 26.33 days in Agrifound Light Red to 32.47 days in Gujarat White. Umbel is the aggregate of many small flowers and single flower in the umbel opened in a sequence. It took 26.22 (Sukhsagar) to 32.66 days (Arka Kalyan) depending on the variety from opening of first to last flower in the umbel (Table 2). This finding suggests for ensuring effective bee activity in the seed production field for at least 60 days starting from the opening of the first flower in a scape for adequate seed production in onion. No variation could be recorded in flower morphology in the genotypes. Individual flowers in the umbel of all the 14 genotypes were white in colour. The perianth segments were 6 in 2 whorls spreading, reflexed, free and ovate.

Table 2. Mean of different floral characters in 14 varieties

Characters / Variety	Days to initiation of scape	Days from scape initiation to opening of first flower in umbel	Days from opening of first to last flower in umbel	Length of anther at anthesis (mm)	Filament length at anthesis (mm)	Style length at anthesis (mm)	Days required for the style to become the same size as of filament	Pollen diameter (micron)	Pollen viability (%)	Pollen germinability (%)	Pollen tube length (micron)
N-53	36.23	32.33	30.16	1.87	2.54	1.37	4.33	10.23	77.05	71.30	38.27
Pusa Red	35.46	29.67	28.37	1.25	2.52	1.13	4.12	10.37	81.71	72.56	33.65
ArkaPragati	33.42	28.35	30.74	1.66	2.86	1.51	4.18	10.42	78.14	69.46	31.78
ArkaKalyan	34.57	30.44	32.66	1.65	2.89	1.52	4.33	10.40	82.42	67.96	31.66
Sukhsagar	41.67	28.66	26.22	1.92	3.58	1.52	6.08	9.87	81.60	68.27	42.36
ADR	33.12	32.54	30.15	1.85	3.75	1.54	6.12	11.40	85.45	75.39	33.63
Baswant-780	37.09	32.33	32.34	1.93	3.78	1.51	5.67	9.88	81.77	69.45	28.93
PhuleSafed	37.55	30.46	28.58	1.90	3.25	1.53	4.67	8.52	83.23	72.37	52.97
PhuleSamrat	35.36	31.67	26.67	1.87	3.12	1.52	4.33	9.45	77.66	69.28	34.52
Agrifound Rose	40.38	30.77	28.48	1.58	2.84	1.27	4.21	9.23	76.87	69.03	29.93
Fursungi local	41.31	28.28	30.23	1.68	2.86	1.43	4.33	10.28	78.83	67.45	28.73
Gujrat White	40.27	32.47	30.34	1.75	3.30	1.17	4.35	10.36	79.24	71.69	36.29
ALR	41.38	26.33	32.55	1.83	3.58	1.53	4.16	10.27	87.63	78.24	41.64
Nasik Red	35.22	32.19	28.25	1.88	2.58	1.47	5.67	10.23	83.60	76.46	40.47
S.E.m	0.19	0.17	0.29	0.08	0.12	0.07	0.19	0.14	0.39	0.56	0.82
C.D. at 5%	0.56	0.49	0.84	0.23	0.35	0.28	0.56	0.41	1.17	1.61	2.36

ADR:Agrifound Dark Red, ALR: Agrifound Light Red

Features of protandry

The normal flower in onion is perfect but it is basically cross-pollinated, chiefly by honey bees mainly due to protandry in which anthers get matured at anthesis but stigma maturity comes few days after. In all the genotypes, the stamens were 6 in number in 2 whorls, each having 3 stamens. Anthers were bilocular and ovary was superior in all the genotypes. Average anther length was 1.76 mm which ranged between 1.25 mm in Pusa Red to 1.93 mm in Baswant 780. Dichogamous self-pollination control mechanism in the bisexual flowers of onion was manifested by differential maturity of the style and filaments at anthesis, average length of the style (1.43 mm; Range: 1.13 – 1.54 mm) being half of that of the filament (3.10 mm; Range: 2.52 – 3.78 mm) at anthesis time in the morning hours (Table 2). It took on an average 4.75 days (Range: 4.18 days in Pusa Red to 6.12 days in Agrifound Dark Red) for the style to mature and become the same size of the filament to reach the vicinity of its own pollens in the anthers (Table 2). However, by this time most of the pollens in the anthers of the same flower have already been shed. So, stigma head of this matured style after 4-6 days of anthesis either gets the viable pollens from the other flowers of the same umbel or different umbel in the course of cross-pollination by the insect pollinizers, creating high chance of both cross-pollination as well as cross-fertilization.

Pollen morphology

The pollen grains were more or less oblong to oval in shape and small, ranging widely between 8.52 micron in Phule Safed and 11.40 micron in Agrifound Dark Red in acetocarmin staining (Table 2).

Pollen viability

The viability of pollen grains in acetocarmine test was, in general, high at the time of anthesis but it varied widely among the genotypes from 76.87% in Agrifound Rose to 87.63% in Agrifound Light Red (Table 2).

In vitro germinability of pollens and pollen tube growth

The artificial culture of pollen grains attracted the attention of the botanists with the discovery of pollen tubes by Amici (1824) in *Portulaca oleracea*. Angiosperm has two groups of pollen viz., binucleate

and trinucleate among which the former one is easy to germinate on artificial media, while the latter one is hard to germinate. In flowering plants, the pollen tube delivers sperm cells to the embryo sac. Pollen tube growth proceeds through tip extension and can be affected by many factors, including temperature, medium osmolarity and the availability of calcium, zinc and boron (Sawidis and Reiss 1995, Taylor and Hepler 1997).

In the present investigation, germination of pollen grains was studied in 20% sucrose + 0.025% of boric acid solution. Observations were made after 4 hours of planting the pollens in the media using the grooved slide method. *In vitro* pollen germinability, in general, was high although it varied widely among the genotypes which ranged between 67.96% in Arka Kalyan and 78.24% in Agrifound Light Red (Table 2). Average pollen tube growth was also adequate in this period ranging between 28.73 micron in Fursungi Local and 52.97 micron in Phule Safed in the germinating medium after 4 hours of planting the pollens. In an earlier report, pollen germination and pollen tube development in onion were greatest in 1% agar + 100 ppm boric acid + 5% kinetin solution (Harikarunakar and Haripriya, 1999). The present investigation and earlier findings indicate that combination of specific concentration of sucrose and boric acid is essential for getting adequate pollen germination of onion. Boron is believed to promote pollen germination by affecting H+-ATPase activity which initiates pollen germination and tube growth (Feijó*et al*., 1995; Obermeyer and Blatt 1995).

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सारांश

प्याज के 14 जीनोटाइपस को लेकर उसके पुष्प विज्ञान का अध्ययन किया गया। सभी जीनोटाइप को कम दिन के उष्णकटिबंधीय प्रकार के 25–35º / 11.74ºC दिन / रात के तापमान में दिसम्बर के अन्तिम सप्ताह से जनवरी के अन्तिम सप्ताह तक प्रेरित किया गया। सभी ग्यारह पुष्प वर्ण जीनोटाइप के बीच काफी विविधता थी। 33.12 से 41.67 दिन बल्ब कि रिट्रान्सप्लान्टीग के लिए आवश्यक है। 26.22 से 32.47 दिन आवश्यक है। अम्बेल में प्रथम फुल लगने के लिए। प्याज उभय लिगीं फूल में डाइकोगैमस आत्म परागण नियंत्रण शैली और फिलामेंट का अन्तर परिपक्वता द्वारा एन्थेसिस में प्रकट किया जाता है और रेशा की औसत लम्बाई (1.43 mm) को आधा किया जा रहा है। कुल खिलने (3.10 mm) के समय पर। पराग अनाज जो छोटे और अधिक या कम अंडाकार आयताकार थे दोनों उच्च और जीनोटाइप के बीच महत्वपूर्ण बदलाव के साथ उपज दिखाते हैं। पराग अंकुरण के लिए उपज द्रव्य के रूप में 20% sucrose 0.025% Boric acid लिया जाता है।

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