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Study on Open Pollination in Tuberose (*Agave amica* Medik.)

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ABSTRACT: Tuberose is one of the commercial important loose as well as cut flower. There is limited diversity in tuberose hence development of new variety with improved growth and yield is required. As the tuberose is self incompatible and dichogamy in nature open pollination was carried out. Seven single type tuberose genotypes were allowed for open pollination. The fruit set was observed in Arka Nirantara, Variegated Single, Bidhan Rajani-2, GK-T-C-4, Bidhan Rajani-3 and there was no fruit set in Arka Prajwal and Bidhan Rajani-1. Maximum fruit set percentage (24.39%), minimum days for fruit maturity (58.66 days) and more number of seeds per capsule (26.77) were recorded in Bidhan Rajani-2 followed by Arka Nirantara. Poor fruit set was observed in Bidhan Rajani-3. Germination and seedling growth of open pollinated seeds were studied. Higher germination percentage was recorded in Bidhan Rajani-2 (76.89%) followed by Arka Nirantara (75.45%) and Bidhan Rajani-3 with lower germination percentage of 20.11%. Growth parameters like number of roots, number of leaves, root length and shoot length were also measured where number of root and shoot were in the range of 1.07-2.03 and 2.02-2.22 in all genotypes respectively. Longest root length was recorded in Arka Nirantara (11.56 cm) and shoot length in Variegated Single (15.34 cm). Vigour index was higher in Arka Nirantara (1994.14) and lower in Bidhan Rajani-3 (458.11).

Keywords: Tuberose, Open pollination, Germination, Diversity, Vigour index.

INTRODUCTION

Tuberose (*Agave amica* Medik.) (Syn. *Polianthes tuberosa* L.) is one of the commercially important bulbous flower crop which belongs to the family Asparagaceae (Chase *et al*., 2016). It is native to Mexico (Bailey, 1919) and is grown wildly in the tropical and subtropical regions of India (Benschop, 1993). It is commonly called as *Rajanigandha or Nishigandha* because of its night blooming habitat. It is cultivated in major states of India like Tamil Nadu, Karnataka, West Bengal, Maharashtra, Haryana, Punjab, Andhra Pradesh, Telangana, Uttar Pradesh and Delhi In India, total production of tuberose is 1,97,210 tonnes (2015-2016) (NHB). In Tamil Nadu, the total area under tuberose cultivation during 2019-20 is 7,654 ha and its production is 66,355 tonnes (Salient Statistics on Agriculture, Agriculture Department, Govt. of Tamil Nadu, 2021).

Tuberose is mainly valued for its ornamental beauty, sweet fragrant spikes with excellent keeping quality (Sadhu and Bose, 1973). Flowers are used in bouquets, garland, floral arrangements, floral ornaments and buttonholes. Tuberose is classified in to three types based on the number of tepal whorls *viz* single (one whorl), semi double (2-3 whorl) and double (more than 3 whorl). Variegated type also available which is used in landscape gardening. Essential oil of tuberose occupies a special place in the international market. Single type is preferred for the concrete extraction over double type because of its high recovery percentage of 0.08- 0.11% by solvent extraction (Singh, 1995) and double type is recommended for cut flower purposes. There is limited variety available in tuberose due to the constraints like self incompatibility, limited genetic resources, dichogamy and poor seed setting (Hemanta *et al*., 2016).

In tuberose, developing new variety with improved quantitative and qualitative character is essential. Before conducting any breeding work thorough knowledge on the plant characteristics is a prerequisite. In tuberose seed setting is quiet erratic in single type, not observed in double type and high percentage of seed setting is found in variegated types (Datta, 2017). Joshi and Pantulu (1940) reported that the reason for sterility in tuberose is not known but it is not due to any defects or deformation in pollen grains and embryo sac

development. Hence, it is possible to create genetic variability in tuberose by allowing genes to express in different combinations. This can be achieved by selecting seedlings from the open pollinated or cross pollinated types (Hemanta *et al*., 2016). With these basic strategies the open pollination study was conducted in selected tuberose genotypes.

MATERIALS AND METHODS

This study was conducted in the Department of Floriculture and Landscape Architecture, Tamil Nadu agricultural university, Coimbatore during the year 2019-2020. Seven single type tuberose genotypes were selected for this study viz, Arka Nirenthara, Variegated Single, GK-T-C-4, Bidhan Rajani-1 (Shnigdha), Bidhan Rajani-2 (Ujwal), Bidhan Rajani-3 (Joythi) and Arka Prajwal (Table 1). Fully developed flower buds in the selected genotypes were allowed for open pollination. Only one spike per plant was used, remaining spikes were bagged to avoid contamination. This experiment was laid out in randomized block design (Panse and Sukhatme 1961). After two weeks, observations like days taken for maturity, number of pods per spike, fruit set percentage and fruit number of seeds per capsule (from fully matured) were recorded.

Table 1: List of genotypes used for open pollination and its characteristics.

Genotype	Characteristics
Arka Nirantara	Single type, Tall and stiff spikes with curvature and pink tinge in tepal tip
Variegated Single	Single type, golden yellow streak along the margin of the leaf
Arka Prajwal	Single type, Tall and stiff spikes with pink tinge in tepal tip
GKTC-4	Single type, dwarf, spike curvature absent
Bidhan Rajani -1 (Shnigdha)	Single type, tall steady spikes with bold florets and pink tinge in tepal tip present
Bidhan Rajani -2 (Ujwal)	Single type, dwarf spikes
Bidhan Rajani -3 (Joythi)	Single type, tall spikes

From the matured pods, the seeds were collected and seed germination study was carried out. Observation *viz*, germination percentage, days taken for seed germination (germination complete once the radicle protruded about 1cm in length), seedling height, vigour index (Germination percentage × (root + shoot length) by Abdul Baki and Anderson, 1973), root and shoot growth was recorded. This experiment was laid out in completely randomized design (Panse and Sukhatme, 1961).

Statistical analysis. Observations recorded were subjected to analysis of variances (ANOVA) using SPSS 20.2 statistical software. The significant difference between the genotypes was determined by least significant difference (LSD) at 5% probability.

RESULT AND DISCUSSION

Open pollination in different genotypes. Initial number of florets per spike of each genotype was recorded before it was allowed for open pollination. It is observed from the Table 2 that maximum number of florets per spike was recorded in BR-I (32.67) followed by Arka Prajwal (31.83) and minimum number of florets was observed in GKTC-4 (27.53).After two weeks of pollination, the fruits starts to develop. Fruit formation was recorded in genotypes such as Arka Nirantara, Variegated Single, GK-T-C-4, Bidhan Rajani-2, Bidhan Rajani-3 and not in Arka Prajwal and Bidhan Rajani-1. Fruit set was not observed in all the genotypes. In some genotypes there was no fruit development. Poor fruit set and failure of fruit formation maybe due to incompatibility, lack of pollen germination and pollen tube growth. Hemanta *et al.* (2016) reported that in open pollination, the low frequency of fruit set and capsule formation may be attributed to the less presence of insect vectors and pollinators. Whereas Bharathi *et al.* (2021) also observed degeneration of embryo sac after zygote formation in genotype Arka Prajwal due to incompatibility. Days taken for maturity was calculated from the day of pollination to the fruit development stage (dried pods). Days taken for fruit maturity were significantly different between the genotypes. Minimum number of days taken for maturity was observed in Bidhan Rajani-2 (58.66) followed by Arka Nirantara (59.34) and maximum days was observed in Variegated Single (64.87).

Bidhan Rajani-2 had higher number of fruit per spike of 7.37 and lower in Bidhan Rajani-3 of 2.12. Percentage fruit set was observed higher in Bidhan Rajani-2 (24.39%) followed by Arka Nirantara (20.93%) and Bidhan Rajani- 3 with a minimum of 6.66% of fruit set. Number of seeds per capsule significantly varies between the genotypes. Maximum number of seeds per capsule was recorded in Bidhan Rajani-2 (26.77) followed by Arka Nirantara (20.43) and minimum seed number was in Bidhan Rajani-3 (15.82). Variation in seed set by different genotype might be due to genetic and environmental factors. Ranchana *et al.* (2014) observed that under open pollination, the highest percentage of fruit set was reported in Variegated Single (89.00%) and similar result was also obtained by Seetharamu *et al.* (2000). In Arka Prajwal the pod abscission observed after crossing was due to post zygotic barrier (Bharathi *et al*., 2021). Similarly, Hemanta *et al*. (2016) also studied open pollination in tuberose and recoded maximum mean number of fruit set (7.33) and percentage of fruit set in a spike (21.77%) in Arka Nirantara. There was no fruit set in Arka Prajwal, this was also observed by Ranchana and Kannan (2016).

Table 2: Open pollination studies in different genotypes.

Genotype	Number of florets/spike	Number of fruit set/spike	Days taken for maturity of fruit	Fruit set percentage	Number of seeds/fruit
Arka Prajwal	31.20	-	-	-	-
Arka Nirantara	30.15	6.31	59.34	20.93 (4.57)	20.43
Variegated single	29.45	4.22	64.87	14.33 (3.79)	17.32
GKT C-4	27.53	4.19	60.21	15.22 (3.90)	16.24
BR-1	32.67	-	-	-	-
BR-2	30.22	7.37	58.66	24.39 (4.94)	26.77
BR-3	31.83	2.12	64.56	6.66 (2.58)	15.82
Mean	30.44	3.46	43.95	11.65 (4.57)	13.80
SE(D)	0.47	0.04	0.19	0.66	0.17
CD (0.05)	1.04	0.08	0.43	1.46	0.38

Values in bracket – Square root transformed

Germination and seedling growth of open pollinated seeds. Matured pods from the genotypes were collected then seeds germination and seedling development were observed (Table 3). There was significant difference among the genotypes in the seed germination characteristics. Minimum number of days taken for seed germination was recorded in Bidhan Rajani-2 (22.13) which is on par with Arka Nirantara (22.56) and maximum number of days was in Bidhan Rajani- 3 (32.48). Germination percentage was observed higher in Bidhan Rajani-2 (76.89%) followed by Arka Nirantara (75.45%) and lower germination percentage in Bidhan Rajani- 3 (20.11). Variation in the days taken for germination and germination percentage may be due to the genetic makeup of the genotype and environmental conditions. Similarly, Raja *et al*. (2003) also observed a maximum of 66% germination in tuberose seeds when fresh seeds were sown and Hemanta (2015) recorded 26% germination.

Seedling growth parameters were recorded after one month of sowing the seeds. Number of roots per seedling was on par between the genotypes. Maximum number was observed in Arka Nirantara (2.13) and minimum number in Bidhan Rajani- 3 (1.07). Number of leaves per seedling was also recorded and mostly in all the genotypes two leaves develops. Higher root and shoot length was recorded in Arka Nirantara (11.56, 15.34 cm respectively), lower root length in Variegated Single (9.44 cm) and lower shoot length in GKTC-4 (10.31). Ranchana *et al* (2014) also studied the germination of open pollinated tuberose seeds with different seed treatments and obtained root length in the range of 7.46-12.80 cm with shoot length range of 7.21-14.40 cm. Based on the germination percentage and seedling growth the vigour index of the genotype was calculated. Maximum vigour index was obtained in Arka Nirantara (1426.01) followed by Bidhan Rajani- 2 (1380.18) and minimum number in Bidhan Rajani- 3 (256.40) (Fig. 1). Similarly, variation in vigour index of China aster genotype was observed by Pandey *et al.* (2017).

Table 3: Seed germination and seedling growth of open pollinated seeds of different genotypes.

Genotypes	Germination percentage	Number of days taken for germination	Number of roots /seedling	Number of leaves /seedling	Root length (cm)	Shoot length (cm)
Arka Nirantara	75.45 (8.69)	22.56	2.03	2.22	11.56	14.87
Variegated single	32.12 (5.67)	28.43	1.86	2.13	9.44	15.34
GKT C-4	30.33 (5.51)	27.68	1.34	2.09	10.78	10.31
BR-2	76.89 (8.77)	22.13	1.96	2.45	11.08	12.56
BR-3	20.11 (4.48)	32.48	1.07	2.01	9.67	13.11
Mean	46.98	26.66	1.65	2.17	10.51	12.83
SE(D)	0.61	0.67	0.12	0.37	0.11	0.16
CD (0.05)	1.30	1.44	0.26	0.79	0.24	0.34

Values in bracket – Square root transformed

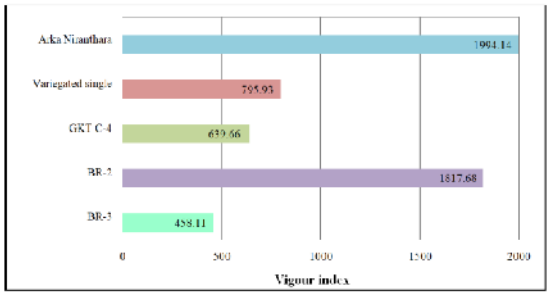

Fig. 1. Vigour index of the seedlings from open pollinated seeds of different genotypes.

CONCLUSION

Open pollination study in tuberose genotypes was conducted to develop a new variety with improved qualitative and quantitative characters. Arka Nirantara and Bidhan Rajani-2 recorded higher fruit set compared to the other genotypes and no fruit was recorded in Arka Prajwal and Bidhan Rajani-1. Fruit set in tuberose was mainly influenced by the genetic and pollen- pistil interaction of the genotypes. Generally, germination of tuberose seeds is very poor where in this study Arka Nirantara and Bidhan Rajani- 2 observed higher germination percentage. Growth parameters of the open pollinated seeds did not exhibit much variation. The growth parameters were influenced by both genetic and environmental conditions. From this, it was concluded that Arka Nirantara and Bidhan Rajani- 2 can be used as a parent for hybrid development. Further evaluation of the open pollinated seedlings was needed for the development of a variety in tuberose.

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