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Screening of tulip (*Tulipa gesneriana* L.) germplasm for quality cut flower and bulb production

R. Kumar*, O.C. Sharma and D.B. Singh

Division of Vegetable Crops and Floriculture, ICAR-Central Institute of Temperate Horticulture, Srinagar 190 007, Jammu and Kashmir

ABSTRACT

A study was conducted to screen tulip genotypes for quality cut flower and bulb production under Kashmir agro-climatic conditions. Twenty tulip genotypes were evaluated. Highest scape length was recorded in Oxford Wonder (35.47 cm) which was at par with Blessing Lady (34.88 cm) and Apeldoorn Elite (33.24 cm). Wide variation was observed in flowering duration (15.25 to 27.24 days) in different genotypes and longest flowering duration was recorded in Purissima Yellow (27.24 days) followed by Apeldoorn Elite (25.20 days), American Dream (24.67 days), Blessing Lady (24.46 days) and Golden Oxford (23.66 days). Genotype Blessing Lady exhibited maximum vase-life 11.67 days, which was at par with Daydream (11.50 days) followed by Purissima Yellow (11.00 days), Golden Oxford (10.67 days) and American Dream (10.50 days). Blessing Lady (3.10), Purissima Yellow (2.80), American Dream (2.72) and Negrita Favorite (2.67) produced higher number of bulbs per plant as compared to lowest in Horizon (1.50). Propagation coefficient was found significantly high in Blessing Lady (354.11%) followed by Purissima White (314.13%), American Dream (308.47%), Apeldoorn Elite (303.12%), Purissima Yellow (297.61%) and Daydream (291.50%) as against lower propagation coefficient (< 200%) in Horizon, Hamilton, Character and Cassini. Based on overall performance several genotypes Blessing Lady, Daydream, Purissima Yellow, American Dream, Apeldoorn Elite and Golden Oxford were found promising in vegetative, floral and bulb production attributes and can be utilized commercially.

Key words: Tulip, flowering duration, vase-life, water relation, propagation coefficient.

INTRODUCTION

Tulip (*Tulipa gesneriana* L.) is an important temperate bulbous flower crop grown in beds, borders and pots for landscaping of gardens and cut flower for commercial purpose. It is originated in Turkey and Central Asia; Holland is known as home of tulip. It is known as queen of bulbs owing to its wide range of genotypes of attractive colours and shapes. It occupies 3rd position in international floriculture trade (Anon, 2). In India, tulips are grown successfully in cold regions of Jammu and Kashmir, Himachal Pradesh and Uttrakhand. The North Western Himalayas is the richest gene centre with about 50 species out of total 100-150 species (Jhon and Neelofer, 8). Its genotypes differ widely in form, size, shape, colour and flowering habit. It needs 17 to 20ºC temperature for flower formation (Ahmed and Khurshid, 1), while less than 5ºC temperature for 10 to 12 weeks is required for forcing. Tulip has been recently introduced in Kashmir Valley, India from Holland and becoming popular in owing to congenial agro-climatic conditions for cut flower and bulb production with low labour cost. In tulip growing, long and strong stem, enhanced flowering duration and vase-life, high multiplication rate of bulbs are major decisive factors. Under Kashmir conditions, flowering initiates during March end and last for 15 to 25 days depending upon genotypes with production of 1 to 2 flowering size bulbs. It has not been growing commercially due lack of quality planting material of suitable genotypes, short flowering duration and low multiplication rate. Quality of bulb is important criteria, other inputs rendered ineffective if the quality of bulb is poor (Jhon *et al*., 10). However, information on suitability of tulip genotypes for cut flower and bulb production are scanty under Kashmir agro-climatic conditions. Therefore, the present study was undertaken.

MATERIALS AND METHODS

The present study was carried out at research field of ICAR-Central Institute of Temperate Horticulture, Srinagar during 2010-14 using 20 tulip genotypes introduced from Holland. The bulbs were procured from Department of Plant Introduction, Directorate of Floriculture, Kashmir, Srinagar, India. The experimental field is situated at about 33°59' N latitude and 74°46' E longitude and 1674.88 m elevation above mean sea level. The soil characteristics of experimental field were clay loam to silt clay, pH 6.83 and EC 0.38 dS m^{-1}

*Corresponding author's present address: Division of Crop Production, ICAR-Central Institute for Arid Horticulture, Bikaner 334 006, Rajasthan; E-mail: rameshflori@gmail.com

with adequate drainage and water holding capacity. Healthy and uniform bulbs of 8 to 12 cm circumference were used as planting material. Prior to planting bulbs were treated with 0.05% carbendazim to avoid bulb rot. The experiment was laid out in randomized block design with three replications and 20 bulbs per treatment were planted during first week of November at the spacing of 20 cm × 20 cm and at a depth of 8 to 10 cm. Uniform intercultural operations were practiced for growing the crop.

The data were recorded on different parameters pertaining to growth, flowering and bulb production of different genotypes. The plant propagation coefficient (%) illustrates bulb multiplication rate, which is the ratio of the total weight of bulbs and daughter bulbs produced and the weight of bulb planted, multiplied by 100 (Kumar *et al*., 13). In vase-life study, tulip scapes were harvested at bud colour break stage in the morning during first week of April. The flowers were precooled at 5°C for about one hour by keeping in modular cold rooms to remove field heat. Then scapes were sorted to uniform length in respective genotypes and lower leaves removed to prevent them touching the preservative solution. After recording initial weight, scapes were placed in conical flask (250 ml) containing vase solution of 8-HQS 300 ppm (Kumar *et al*., 12). 8-HQS dealys the senescence of cut tulip due to cytokinin-like activity and inhibition of ethylene production, which maintains better water balance leading to improved vase-life. The experiment was laid out in completely randomized design (CRD) with three replications. The flasks were plugged with cotton to prevent loss of water due to evaporation. The experiment was conducted at temperature of 14 ± 3°C with relative humidity 70 ± 5% under natural light. Data were recorded on water uptake, water loss, water balance and stem bending incidence on 10th day when more than 90% flower wilted. Data were analyzed statistically as per the methods suggested by Gomez and Gomez (5). The critical difference (CD) value was used to determine difference between treatments worked out at 5% level of significance (Chandel, 3).

RESULTS AND DISCUSSION

The tulip genotypes exhibited wide variation for vegetative, floral and bulb attributes. The data presented in Table 1 revealed that there were significant variations among different genotypes with respect to vegetative attributes. Among all the

Table 1. Vegetative attributes of tulip genotypes under of Kashmir agro-climatic conditions.

Genotype	Days to sprouting	Sprouting per cent	Plant height (cm)	Leaf No. /plant	Wrapper leaf area (cm^2)	Field life (days)
Purissima White	73.15	93.00	29.67	3.25	121.25	192.25
Negrita Favorite	87.33	86.00	32.16	4.60	93.67	185.33
Kungfu	72.67	84.33	30.47	3.75	87.00	179.36
Ali Bi	83.00	80.25	28.50	4.10	120.00	184.22
Purissima Yellow	72.35	92.45	26.25	4.00	110.33	187.67
Banja Luka	88.25	87.50	34.47	4.55	108.00	187.33
Daydream	76.21	92.00	37.08	4.60	120.24	184.12
Oxford Wonder	72.50	85.00	42.96	3.70	123.14	182.26
Blessing Lady	95.45	100.00	42.60	3.33	125.46	195.79
Hamilton	92.71	74.00	26.34	3.50	90.27	176.55
Apeldoorn	85.00	98.00	32.00	3.45	124.00	181.17
Lle de France	84.13	76.00	34.50	3.60	90.17	186.23
American Dream	88.25	81.00	33.24	3.45	120.10	190.00
Apeldoorn Elite	90.55	93.00	38.71	3.67	112.45	188.50
Horizon	91.14	72.00	22.40	3.00	70.00	175.34
Cassini	82.47	75.23	23.70	4.00	100.90	177.42
Orange Emperor	75.15	76.00	29.78	4.00	117.48	180.30
Golden Oxford	89.45	80.00	26.80	3.50	127.00	187.95
Character	83.32	72.00	33.00	3.00	82.67	177.35
Leen van der Mark	71.78	77.33	20.10	3.00	86.21	186.22
CD at 5%	4.31	5.20	3.75	0.59	10.78	6.95

genotypes earliest sprouting was recorded in Leen van der Mark (71.78 days) followed by Purissima Yellow (72.35 days), Oxford Wonder (72.50 days) while delayed sprouting was observed in Blessing Lady (95.45 days) and Hamilton (92.71 days). Sprouting percentage was varied significantly among the genotypes and recorded maximum 100% in Blessing Lady followed by 98% in Apeldoorn as compared to minimum (72%) in both Horizon and Character. Plant height was recorded highest in Oxford Wonder (42.96 cm) followed by Blessing Lady (42.60 cm), whereas it was recorded minimum in Leen van der Mark (20.10 cm) and Horizon (22.40 cm). Leaf number per plant varied from 3.00 to 4.60 among different genotypes. The leaves are already developed inside the bulbs their expression may possibly depend upon bulb health, genetic makeup of plant and environmental characteristic. Leaves are major site of photosynthesis and more the leaf area higher the photosynthesis, which ultimately improves flower and bulb size. Maximum wrapper leaf area was recorded (127.00 cm^2) in Golden Oxford followed by Blessing lady (125.46 cm^2), Apeldoorn (124.00 cm^2) and Oxford Wonder (123.14 cm^2). Number of days from planting of bulbs to drying of plants was mentioned as field life and plays important role in bulb development. It ranged from minimum 175.34 days in Horizon to maximum 195.79 days in Blessing Lady. Similar type of variation for different vegetative attributes was also reported by Jhon and Khan (7) in tulip.

In tulip cut flower production scape length, straightness and flower size are important criteria along with prolonged flowering duration and vase life. Data presented in Table 2 divulged that floral attributes significantly influenced by different genotypes. Earliest flower bud appearance was observed in Purissima White (128.22 days) followed by Oxford Wonder (129.07 days) and Purissima Yellow (129.25 days). Earliest flowering was recorded in Purissima White (135.50 days) followed by 137.00 days in both Purissima Yellow and Oxford Wonder, while delayed flowering was recorded in Blessing Lady (160.42 days) and Horizon (158.38 days). Wide variation was observed with respect to flowering duration and genotypes, which flowered up to end of March, first fortnight of April and second fortnight of April are categorized as early, mid and late flowering,

Table 2. Floral attributes of different tulip genotypes under Kashmir agro-climatic conditions.

Genotype	Days to bud appearance	Days to flowering	Scape length (cm)	Scape thickness (mm)	Flower size (cm)	Flowering duration (days)
Purissima White	128.22	135.50	26.00	6.94	7.45	15.25
Negrita Favorite	143.11	151.46	29.23	6.05	5.20	20.14
Kungfu	130.14	138.25	26.58	6.46	5.81	22.04
Ali Bi	141.36	148.50	23.50	6.55	5.69	22.00
Purissima Yellow	129.25	137.00	22.11	7.25	5.78	27.24
Banja Luka	146.50	154.33	31.57	7.22	5.81	19.47
Daydream	134.05	143.25	32.05	7.33	6.30	20.29
Oxford Wonder	129.07	137.00	35.47	9.02	8.10	19.50
Blessing Lady	151.67	160.42	34.88	8.64	6.25	24.46
Hamilton	152.33	157.24	22.27	6.23	6.89	19.00
Apeldoorn	143.25	151.00	28.60	6.95	6.12	23.33
Lle de France	142.05	150.50	30.20	6.22	7.04	20.25
American Dream	147.22	155.26	30.10	8.90	5.83	24.67
Apeldoorn Elite	144.10	153.24	33.24	7.17	7.35	25.20
Horizon	149.07	158.38	20.06	6.23	7.00	22.17
Cassini	132.75	139.00	21.27	6.46	6.81	20.06
Orange Emperor	133.96	140.00	25.61	5.62	5.98	22.47
Golden Oxford	147.33	155.23	24.10	8.80	7.20	23.66
Character	138.38	147.00	30.07	6.21	6.00	20.24
Leen van der Mark	129.52	138.33	19.00	6.59	5.15	21.06
CD at 5%	6.07	4.24	3.09	0.98	0.35	2.91

respectively. Genotypes Purissima White, Purissima Yellow, Kungfu, Oxford Wonder, Cassini, Orange Emperor and Leen van der Mark are early flowering, whereas Hamilton, Blessing Lady, Horizon, American Dream and Golden Oxford comes under late category and others Negrita Favorite, Ali Bi, Banja Luka, Daydream, Apeldoorn, Lle de France, Apeldoorn Elite and Character are mid flowering genotypes. Hence, these variations can be utilized for extending flowering duration in tulip. Early, mid and late flowering in tulip might be due different genetic makeup of genotypes and these findings are in conformity with the results of John and Khan (7).

Scape length significantly influenced by different genotypes and longest scape was recorded in Oxford Wonder (35.47 cm), which was at par with Blessing Lady (34.88 cm), while it was recorded shortest (19.00 and 21.27 cm) in Leen van der Mark and Cassini, respectively. It may be possibly due to varied bulb size and genetic differences among genotypes. Scape thickness was recorded maximum in Oxford Wonder (9.02 mm) followed by American Dream (8.90 mm), Golden Oxford (8.80 mm) and Blessing Lady (8.64 mm) as compared to minimum in Orange Emperor (5.62 mm). Oxford Wonder (8.10 cm) and Purissima White (7.45 cm) produced largest size flowers as against smallest in Leen van der Mark (5.15 cm) and Negrita Favorite (5.20 cm). Similar differences in floral attributes of tulip were obtained by John and Khan (7); and Ahmed and Khurshid (1). Flowering duration extended from 15.25 to 27.24 days in different genotypes and genotypes Purissima Yellow (27.24 days), Apeldoorn Elite (25.20 days), American Dream (24.67 days) and Blessing Lady (24.46 days) were found superior over others with longer flowering duration.

In vase-life study, significant variations recorded among the genotypes with respect to flower fresh weight and water relation parameters (Table 3). Flower fresh weight varied from 10.60 to 26.38 g among different genotypes, which is due to diverse scape length and genetic difference. Highest flower fresh weight was recorded in Blessing Lady (26.38 g), which was at par with Oxford Wonder (24.69 g) and Daydream (24.57 g). Water uptake per scape was found higher in Blessing Lady (25.69 g), Oxford

Table 3. Vase-life study on different tulip genotypes.

Genotype	Flower fresh wt. (g)	Water relation parameter (g/ scape)			Bending incidence (%)		
		Water uptake	Water loss	Water balance	0-30°	30-60°	>60°
Purissima White	17.00	13.30	15.03	-1.73	30	60	10
Negrita Favorite	10.60	12.74	12.75	-0.01	10	30	60
Kungfu	12.60	18.92	19.85	-0.93	70	30	0
Ali Bi	15.40	18.64	19.74	-1.10	80	10	10
Purissima Yellow	16.72	23.54	21.94	1.60	90	10	10
Banja Luka	21.35	22.67	23.00	-0.33	60	40	0
Daydream	24.57	23.41	21.46	1.95	60	30	10
Oxford Wonder	24.69	24.80	25.85	-1.05	80	20	0
Blessing Lady	26.38	25.69	23.10	2.59	50	40	10
Hamilton	16.33	20.05	20.80	-0.75	30	70	0
Apeldoorn	18.80	22.07	22.49	-0.42	20	60	20
Lle de France	17.12	22.81	23.31	-0.50	30	40	30
American Dream	18.49	23.74	22.72	1.02	70	30	0
Apeldoorn Elite	20.26	22.00	21.46	0.54	90	10	0
Horizon	13.95	16.59	17.98	-1.39	20	60	20
Cassini	13.80	17.34	18.84	-1.50	10	70	20
Orange Emperor	16.78	19.68	20.50	-0.82	10	30	60
Golden Oxford	21.92	18.64	18.44	0.20	60	40	0
Character	14.53	16.50	18.17	-1.67	30	50	20
Leen van der Mark	12.77	13.08	13.15	-0.07	30	60	10
CD at 5%	2.87	1.87	2.02	0.23			

Wonder (24.80 g) and American Dream (23.74 g), while water loss per scape was recorded highest in Oxford Wonder (25.85 g) followed by Lle de France (23.31 g) and Blessing Lady (23.10 g). Genotypes Blessing Lady (2.59 g), Daydream (1.95 g), Purissima Yellow (1.60 g), American Dream (1.02 g), Apeldoorn Elite (0.54 g) and Golden Oxford (0.20 g) expressed positive and maximum water balance at the end of vase life. Most of scapes from Purissima Yellow (90%), Apeldoorn Elite (90%), Oxford Wonder (80%), Ali Bi (80%), American Dream (70%) and Kungfu (70%) expressed low stem bending incidence (0-30°). Perusal of data divulged that stem bending incidence is genotype dependent and varies from genotype to genotype, these findings corroborated the earlier work of Kim *et al*. (11) in tulip and Ferrante *et al.* (4) in gerbera. Longest vase-life (Fig. 1) was recorded 11.67 days in Blessing Lady followed by Daydream (11.50 days), Purissima Yellow (11.00 days), Golden Oxford (10.67 days), American Dream (10.50 days) and Apeldoorn Elite (10.25 days) as against shortest in Purissima White (6.50 days). The variation in vase-life among genotypes may be due to inherent traits (Gondhali *et al*., 6), which resulted in varied water relation parameters and disturbed water balance.

In successful tulip cultivation, production of flower grade bulb is priority criteria due to low multiplication rate. It may be possibly due to lack of adaptable genotypes, improper forcing/ growing techniques, bulb rot problem and improper bulb storage. Bulbs of more than 10 to 12 cm circumference can produce flowers and termed as flower grade bulbs. Number of bulbs per plant significantly affected by different genotypes (Table 4). Genotype Blessing Lady (3.10) produced highest number of bulbs per plant, which was at par with Purissima Yellow (2.80) and American Dream (2.72), while lowest was in Horizon (1.50). These results are in conformity with findings of John and Khan (7) and Jhon *et al.* (9). Bulb size found maximum in Oxford Wonder (13.07 cm), Purissima White (12.91 cm), Apeldoorn Elite (12.67 cm), Purissima Yellow (12.36 cm) and Blessing Lady (12.27 cm), which were statistically superior over other genotypes, whereas Oxford Wonder (20.20 g), Purissima White (20.11 g) and Banja Luka (19.23 g) found better over others with respect to bulb weight. Lowest bulb weight was recorded in Hamilton (9.22 g), Character (10.11 g) and Horizon (10.23 g).

Number of daughter bulbs per plant was recorded significantly high in Apeldoorn Elite (2.50), Blessing Lady (2.49), Oxford Wonder (2.37) and Daydream (2.25) over others genotypes. Daughter bulbs weight per plant was found highest 7.23 g in Blessing Lady and was at par with Golden Oxford (6.71 g). Similar type of variation in bulbs and bulblets production was also noticed by Jhon *et al.* (9) in tulip. Total bulb yield (t/ ha) differed significantly among different genotypes and Blessing Lady was found significantly superior over other genotypes with highest total bulb yield of 15.93 t/ha followed by 13.39 t/ha in Purissima Yellow, 13.14 t/ha in Oxford Wonder. Lowest total bulb yield was recorded 4.62, 5.00 and 5.32 t/ha in Horizon, Character and Hamilton, respectively. Propagation coefficient recorded highest 354.11% in Blessing Lady, which is significantly superior (Fig. 2) over other genotypes. Genotypes Purissima White (314.13%), American Dream (308.47%), Apeldoorn Elite (303.12%) and Purissima Yellow (297.61%) were also found promising with high propagation coefficient. This may be due to enhanced leaf area

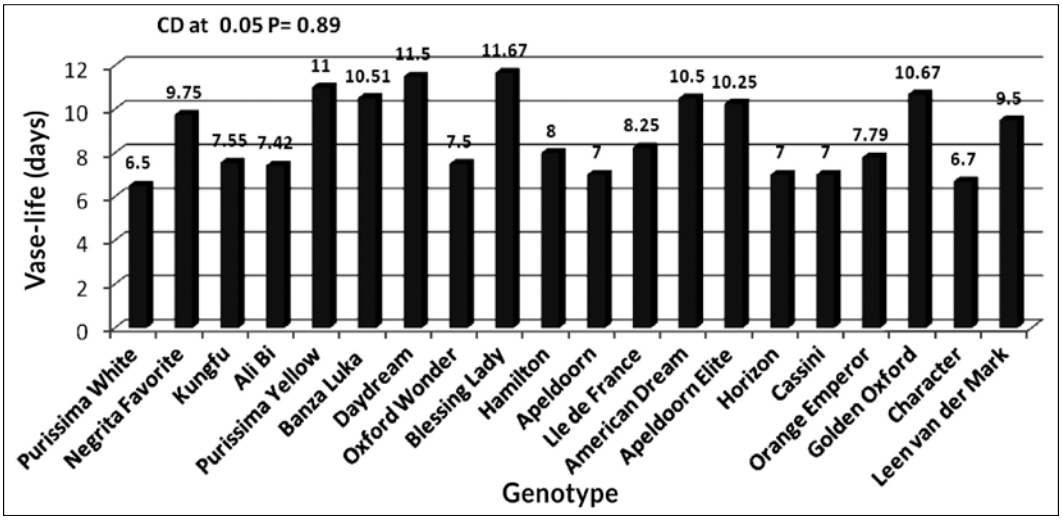

Fig. 1. Vase-life of different tulip genotypes.

Table 4. Bulb attributes of different tulip genotypes under Kashmir agro-climatic conditions.

Genotype	Bulb No./ plant	Bulb size (cm)	Bulb wt. (g)	No. of daughter bulbs/ plant	Daughter bulbs wt./ plant (g)	Total bulb yield (t/ha)
Purissima White	2.17	12.91	20.11	1.23	3.49	11.78
Negrita Favorite	2.67	11.17	12.82	1.00	3.11	9.33
Kungfu	2.00	11.05	14.11	1.21	3.07	7.82
Ali Bi	2.50	11.10	12.17	1.37	3.25	8.41
Purissima Yellow	2.80	12.36	17.50	2.13	4.57	13.39
Banja Luka	2.01	12.15	19.23	1.12	3.62	10.56
Daydream	2.60	11.87	18.00	2.25	5.67	13.11
Oxford Wonder	2.30	13.07	20.20	2.37	6.12	13.14
Blessing Lady	3.10	12.27	18.23	2.49	7.23	15.93
Hamilton	1.97	9.23	9.22	1.67	3.12	5.32
Apeldoorn	2.17	11.67	15.12	1.96	3.65	8.61
Lle de France	2.21	10.11	12.34	1.12	3.11	7.59
American Dream	2.72	11.27	17.33	2.17	6.17	13.11
Apeldoorn Elite	2.60	12.67	16.26	2.50	6.23	12.12
Horizon	1.50	9.02	10.23	1.62	3.14	4.62
Cassini	2.00	8.12	11.14	1.12	3.37	6.41
Orange Emperor	1.85	9.87	13.18	1.53	4.12	7.12
Golden Oxford	2.33	12.17	13.17	2.17	6.71	9.34
Character	1.67	10.33	10.11	1.54	3.13	5.00
Leen van der Mark	2.34	9.67	11.25	1.67	4.17	7.62
CD at 5%	0.40	1.57	2.93	0.48	0.78	1.24

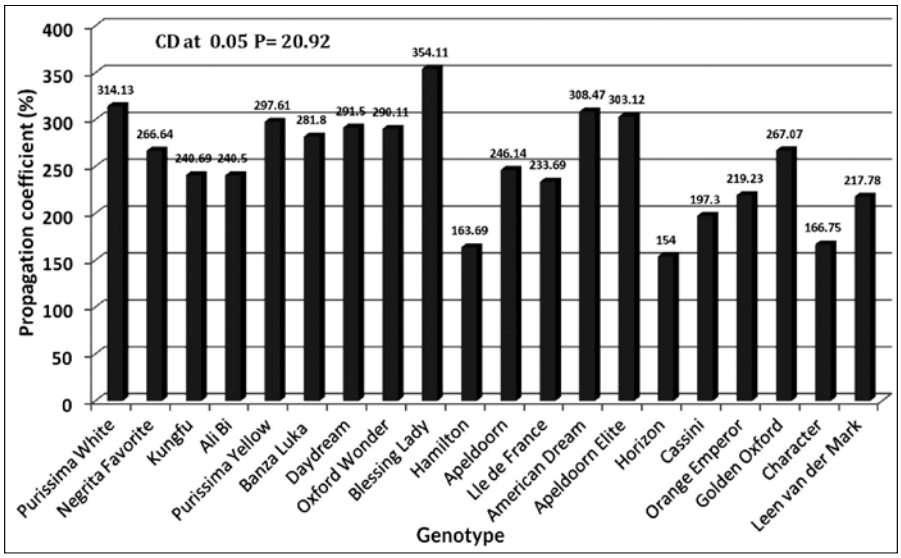

Fig. 2. Propagation coefficient of tulip genotypes.

and extended field life. It was recorded lowest in genotypes Horizon (154.00%), Hamilton (163.69%), Character (166.75%) and Cassini (197.30%) owing to low bulb multiplication rate.

Tulip is gaining popularity among the flower growers in Kashmir Valley because of increasing demand of its cut flowers and bulbs owing to highly attractive, dazzling flowers of uniform shape and size

with huge variation in colour and form. Its cultivation is a lucrative enterprise and flowers are sold at Rs. 20 to 30 per cut stem, while bulbs fetch Rs. 10 to 20 per bulb both in national and international markets. Based on performance genotypes Blessing Lady, Daydream, Purissima Yellow, American Dream, Apeldoorn Elite and Golden Oxford were found promising and can be utilized commercially for quality cut flower and bulb production.

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