Short Communication

Garlic variety Yamuna Safed-3 - a good performer in rain shadow region of high ranges of Idukki, Kerala

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Abstract

A study was conducted to evaluate performance of garlic varieties in the rain shadow region of high ranges of Kerala. Nine released varieties were compared with the local cultivar in farmers' fields of Kanthalloor panchayat. The results revealed that local cultivar and Yamuna Safed-3 recorded high fresh bulb weight. Highest yield of 1.19kg/2m^2 was recorded by Yamuna Safed-3, followed by local cultivar and Ooty-1 (0.90kg/2m^2 and 0.89kg/2m^2 respectively). Fresh bulb weight showed highly significant positive correlation with plant height, neck thickness, equatorial diameter, polar diameter and clove length. Highest yield per plot, fresh bulb weight, polar diameter of bulb and clove length were recorded in Yamuna Safed-3, and it was found suitable for the agro climatic situations of Kanthalloor.

Keywords: Bulb yield, Garlic, High ranges of Kerala, Kanthalloor, Varieties.

Garlic (*Allium sativum* L.), is used as a spice or condiment throughout the country. Allicin (diallylthiosulfinate) is the volatile compound responsible for the pungent smell of garlic. Most of the medicinal effects of garlic are attributed to this sulphur compound.

India ranks second to China in area and production of garlic in the world. In Kerala, garlic is cultivated in an area of 80ha with a production of 630 t (DASD, 2016) and its cultivation is confined to Devikulam block of Idukki district with commercial plots in Kanthalloor and Vattavada panchayats (Menon et al., 2017).

A wide range of adaptability of garlic to different soil types, temperatures and day lengths, makes its cultivation possible from the tropics to temperate regions. Umamaheswarappa et al. (2014) reported that garlic cultivars showed wide variation in their yielding ability when grown over varied agro-climatic conditions. Information on the performance of improved garlic varieties in the traditional growing tract of Kerala is lacking. In this background, the present study was undertaken to evaluate the performance of various garlic genotypes for yield in the rain shadow region of Kerala.

The study was conducted in farmer's fields in two locations of Kanthalloor panchayat of Idukki district which comes under Marayur rain shadow region. The area lies between 10° 132 N latitude and 77° 112 E longitude with an altitude of 5800 ft above Mean Sea Level. Soil texture of the experimental site was loam to clay loam. The area represents low rainfall region having a tropical sub humid monsoon climate with an average annual temperature of 18.9 °C and a rainfall of 1276 mm. The study comprised the evaluation of ten varieties *viz.,* Yamuna Safed, Yamuna Safed-2, Yamuna Safed-3, Yamuna Safed-8, Yamuna Safed-9, Bhima Omkar, Bhima Purple, AAS-2, Ooty-1 and a local cultivar. The local cultivar is the traditional cultivar

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grown by the farmers, with the seeds collected from Mettupalayam market. The seed cloves of garlic varieties were dibbled in flat beds of 2 m^2 size at a spacing of 15 cm x 8 cm in randomized block design with three replications. The recommended package of practices of KAU (2016) were followed for raising the crop during May-September 2017.

Observations on plant biometric characters like plant height (cm), number of leaves per plant and neck thickness (cm) at two months after planting were recorded from ten randomly selected plants in each plot. The bulbs were harvested at maturity and the observations on morphological bulb characters *i.e*., bulb shape in longitudinal and cross sections, bulb colour, distribution of garlic cloves, clove skin colour and clove flesh colour were taken as per NBPGR and PPV&FRA characteristics (Mahajan et al., 2000). Observations on yield parameters *viz.,* equatorial diameter (cm), polar diameter (cm), fresh bulb weight (g), cured bulb weight (g), number of cloves per bulb, clove length (cm), clove width (cm), clove weight (g), and clove skin thickness (mm) were taken from randomly selected garlic bulbs. Cured yield per plot (kg) was recorded and yield per hectare (t) was also calculated. Significance of difference among the genotypes was tested statistically using WASP 2.0 and the correlation between fresh bulb weight and yield contributing characters of field 1 (F1) was done using SPSS 16.0.

Data on biometric characters at two months after planting are shown in Table 1. The local cultivar recorded greatest plant height (37.63 cm), followed by AAS-2 (34.72 cm). The plant height of Yamuna Safed-3 (34.12 cm) was also on par with that of AAS-2. Umamaheswarappa et al. (2014) recorded a greater plant height of 46.10 cm in Yamuna Safed-3 at 70 days after planting. In general the plant heights recorded were comparatively low. It has been reported by Tesfay et al. (2011) that the difference in plant height of onion was mainly attributed to the genetic potential of cultivar as well as the environmental factors, especially temperature and photoperiod.

A high neck thickness was recorded in the local cultivar (2.16 cm) followed by Yamuna Safed-3 (1.86 cm). Pooled analysis showed that number of leaves per plant was higher in AAS-2 (6.30) followed by local cultivar and Yamuna Safed-3 (5.76 and 5.53 respectively).

Umamaheswarappa et al. (2014) reported highest number of leaves *i.e.,* 13.87, in Yamuna Safed-3 in a field experiment conducted under central dry zone of Karnataka among the eleven garlic genotypes studied. The increased number of leaves helped in accumulation of photosynthates and their utilization for the build-up of new cells resulting in increased dry matter production (Singh et al., 2013; Umamaheswarappa et al., 2014).

Table 1. Field survival and biometric plant characters of garlic varieties at two months after planting

Varieties	Field survival (%)			Plant height (cm)			Number of leaves			Neck thickness (cm)		
	F1	F2	Pooled	F1	F2	Pooled	F1	F2	Pooled	F1	F2	Pooled
Yamuna Safed	94.89^{ab}	78.22^{cd}	86.55^{bc}	27.52^{de}	20.79	24.16^{e}	4.8^{bc}	3.83	4.32^{c}	1.40^{cd}	1.10	1.25^{e}
Yamuna Safed-2	94.22^{ab}	91.56^{ab}	92.89^{ab}	28.08^{de}	22.39	25.24^{e}	4.8^{bc}	4.23	4.52^{c}	1.47^{cd}	1.21	1.34^{de}
Yamuna Safed-3	97.33^{a}	94.67^{a}	96.00^{a}	36.64^{abc}	31.61	34.12^{bc}	5.73^{ab}	5.33	5.53^{b}	2.00^{b}	1.72	1.86^{b}
Yamuna Safed-8	96.44^{a}	89.11^{abc}	92.78^{ab}	32.11^{cd}	24.67	28.39^{cde}	4.9^{bc}	4.43	4.67^{c}	1.52^{cd}	1.42	1.47^{cde}
Yamuna Safed-9	99.56^{a}	94.44^{a}	97.00^{a}	35.61^{bc}	29.58	32.60^{bc}	4.30^{c}	3.90	4.10^{c}	1.44^{cd}	1.33	1.39^{de}
Bhima Omkar	78.89^{c}	80.66^{bc}	79.78^{cd}	24.67^{e}	25.31	24.99^{e}	4.77^{c}	4.57	4.67^{c}	1.28^{d}	1.33	1.30^{de}
Bhima Purple	90.22^{ab}	82.44^{abc}	86.33^{bc}	26.91^{de}	25.57	26.24^{e}	4.40^{c}	4.33	4.37^{c}	1.49^{cd}	1.45	1.47^{cde}
AAS-2	98.00^{a}	94.00^{a}	96.00^{a}	38.82^{ab}	30.62	34.72^{b}	6.67^{a}	5.93	6.30^{a}	1.71^{bc}	1.67	1.69^{bc}
Ooty-1	84.89^{bc}	83.78^{abc}	84.33^{c}	32.31^{cd}	22.55	27.43^{de}	4.97^{bc}	4.13	4.55^{c}	1.78^{bc}	1.41	1.60^{bcd}
Local cultivar	76.89^{c}	67.04^{d}	71.96^{d}	41.88^{a}	33.37	37.63^{a}	6.43^{a}	5.08	5.76^{b}	2.56^{a}	1.76	2.16^{a}
CD (0.05)	10.94	12.36	7.92	5.94	NS	6.18	0.94	NS	0.82	0.39	NS	0.36

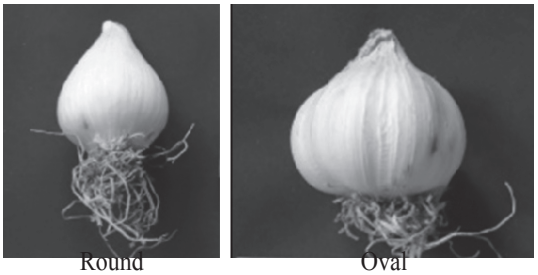
Table 2. Morphological bulb characters of garlic varieties

Varieties	Bulb colour	Bulb shape in longitudinal section	Bulb shape in cross section	Distribution of cloves	Clove skin colour	Clove flesh colour
Yamuna Safed	White	Oval	Elliptic	Non- radial	Cream	Yellow
Yamuna Safed-2	Cream	Oval	Elliptic	Non- radial	Cream	Yellow
Yamuna Safed-3	Cream	Oval	Elliptic	Non- radial	Cream	Yellow
Yamuna Safed-8	White	Round	Circular	Not Applicable	Cream	Yellow
Yamuna Safed-9	Purple	Oval	Elliptic	Non- radial	Purple	Yellow
Bhima Omkar	White	Oval	Elliptic	Non- radial	Cream	Yellow
Bhima Purple	Purple	Oval	Elliptic	Non- radial	Purple	Yellow
AAS-2	Pink	Oval	Circular	Radial	Pink	Yellow
Ooty-1	Cream	Oval	Circular	Radial	Cream	Yellow
Local cultivar	Cream	Oval	Elliptic	Non- radial	Cream	Yellow

The morphological characters of bulbs are depicted in Table 2. The bulbs were white in colour in Yamuna Safed, Yamuna Safed-8 and Bhima Omkar. Purple shade was noticed in the bulb skin of Yamuna Safed-9 and Bhima Purple, whereas, AAS-2 showed pink shade in the bulb skin. In all other varieties bulbs were cream in colour. But the consumer preference is more for white bulbs.

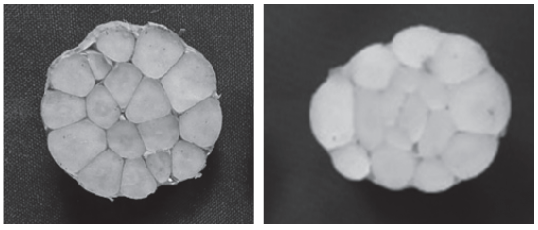
In all genotypes, bulbs were oval in shape in longitudinal section except Yamuna Safed-8 in which it was round shaped (Plate 1). In general bulbs were elliptical in cross section, but circular shaped bulbs were noticed in Yamuna Safed-8, AAS-2 and Ooty-1 (Plate 2).

Plate 1. Shape of bulbs in longitudinal section



Round Oval

Plate 2. Shape of bulbs in cross section

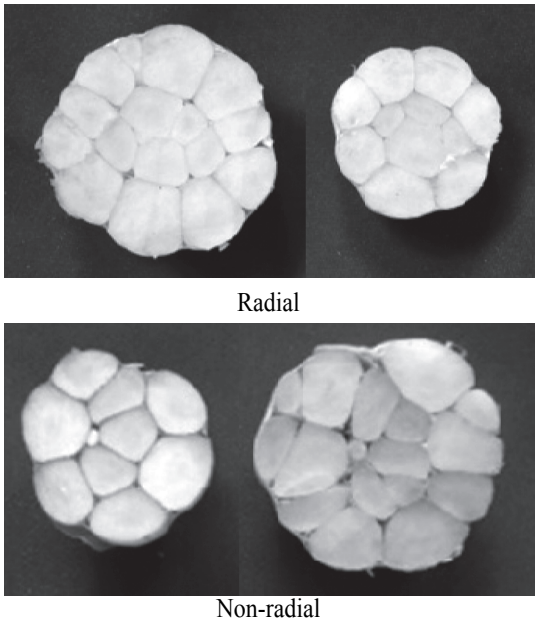


Circular Elliptic

In the present study skin colour of clove was cream in all genotypes except for Yamuna Safed-9 and Bhima Purple in which it was purple, and in AAS-2 in which it was pink. The clove skin was pinkish coloured in Yamuna Safed-3 in a study under the subtropical climatic conditions of Haryana (Mishra et al., 2013). Invariably clove flesh colour was yellow in all the varieties evaluated. Radial clove distribution was observed in AAS-2 and Ooty-1 whereas, it was non-radial in all other genotypes (Plate 3).

Bulb characteristics of various garlic varieties are shown in Table 3. The local cultivar and Yamuna Safed-3 recorded a higher equatorial diameter

Plate 3. Distribution of cloves in garlic genotype



Radial

Non-radial

Table 3. Bulb characteristics of garlic varieties

Varieties	Equatorial diameter(cm)			Polar diameter (cm)			Fresh bulb weight (g)			Cured bulb weight (g)			Cured yield/ plot (Kg)		
	F1	F2	Pooled	F1	F2	Pooled	F1	F2	Pooled	F1	F2	Pooled	F1	F2	Pooled
Yamuna Safed	2.42^{d}	2.41^{cd}	2.42^{cd}	2.99^{de}	3.57^{a}	3.28^{bc}	8.19^{bc}	6.25^{b}	7.22^{c}	6.00^{de}	5.52^{b}	5.76^{bc}	0.50^{e}	0.50^{b}	0.50^{c}
Yamuna Safed-2	2.37^{d}	1.52^{f}	1.94^{f}	3.08^{cd}	2.25^{de}	2.66^{e}	6.06^{c}	4.53^{b}	5.30^{c}	5.08^{e}	2.51^{b}	3.80^{d}	0.47^{e}	0.41^{b}	0.44^{c}
Yamuna Safed-3	3.08^{abc}	3.11^{ab}	3.09^{a}	3.52^{a}	3.73^{a}	3.62^{a}	14.98^{a}	15.63^{a}	15.31^{a}	11.38^{ab}	10.90^{a}	11.14^{a}	1.03^{b}	1.36^{a}	1.19^{a}
Yamuna Safed-8	2.36^{d}	1.63^{ef}	2.00^{ef}	3.48^{a}	2.20^{e}	2.84^{de}	8.61^{bc}	4.87^{b}	6.74^{c}	7.16^{cde}	3.34^{b}	5.25^{cd}	0.83^{bcd}	0.37^{b}	0.60^{c}
Yamuna Safed-9	2.76^{cd}	1.88^{ef}	2.32^{de}	3.47^{a}	2.76^{bc}	3.12^{c}	11.29^{b}	4.42^{b}	7.85^{c}	7.99^{cd}	2.87^{b}	5.43^{bcd}	0.91^{bc}	0.36^{b}	0.63^{bc}
Bhima Omkar	2.73^{cd}	2.05^{de}	2.39^{cd}	3.33^{abc}	2.97^{b}	3.15^{c}	9.45^{b}	5.43^{b}	7.44^{c}	7.25^{cde}	3.67^{b}	5.46^{bcd}	0.61^{de}	0.38^{b}	0.49^{c}
Bhima Purple	2.68^{cd}	2.09^{de}	2.38^{cd}	3.15^{bcd}	2.41^{cde}	2.78^{e}	8.80^{bc}	4.86^{b}	6.83^{c}	6.26^{de}	3.33^{b}	4.80^{cd}	0.66^{cde}	0.36^{b}	0.51^{c}
AAS-2	2.80^{bcd}	2.61^{bc}	2.71^{bc}	2.76^{e}	2.60^{bcde}	2.68^{e}	9.22^{b}	5.45^{b}	7.33^{c}	7.72^{cd}	4.92^{b}	6.32^{bc}	0.90^{bc}	0.42^{b}	0.66^{bc}
Ooty-1	3.49^{a}	2.46^{cd}	2.97^{ab}	3.51^{a}	2.70^{bcd}	3.10^{cd}	15.42^{a}	6.67^{b}	11.04^{b}	8.97^{bc}	5.52^{b}	7.24^{b}	1.39^{a}	0.40^{b}	0.89^{b}
Local cultivar	3.28^{ab}	3.28^{a}	3.28^{a}	3.42^{ab}	3.50^{a}	3.46^{ab}	16.89^{a}	14.43^{a}	15.66^{a}	13.59^{a}	11.06^{a}	12.33^{a}	1.09^{b}	0.70^{b}	0.90^{b}
CD (0.05)	0.49	0.52	0.34	0.30	0.46	0.28	3.10	4.80	2.72	2.56	3.08	1.90	0.29	0.50	0.28

(3.28 cm and 3.09 cm respectively). The polar diameter was highest in Yamuna Safed-3 (3.62 cm) and local cultivar also recorded a comparable value of 3.46 cm. In general equatorial diameter of the bulbs ranged from 1.94 cm to 3.28 cm, whereas the polar diameter was in the range of 2.66 cm to 3.62 cm among the varieties studied. Polar diameter and equatorial diameter determine the shape and size of the bulb which is an important attribute for its market value (Ratan et al., 2017).

In pooled analysis, the local cultivar and Yamuna Safed-3 were superior in fresh bulb weight and cured bulb weight followed by Ooty-1. According to Sandhu et al. (2015) and Sharma et al. (2015) bulb weight is the most important yield contributing component.

The observations on clove characteristics of garlic varieties are given in Table 4. It was observed that AAS-2 was superior in terms of number of cloves (16.83) and Yamuna Safed-3 (14.47) was on par with AAS-2. Lowest number of cloves per bulb was observed in Yamuna Safed-8 (2.81), which failed to differentiate cloves in the Kanthalloor agro ecological situation in the season May to September. About 79.16 % of the bulbs produced were single clove bulbs in Yamuna Safed-8. The genotypes Yamuna Safed-2 and Yamuna Safed were also poor in clove differentiation and single clove bulbs were observed in the experimental field to the tune of 25.17 % and 22.26 % respectively (Fig 1).

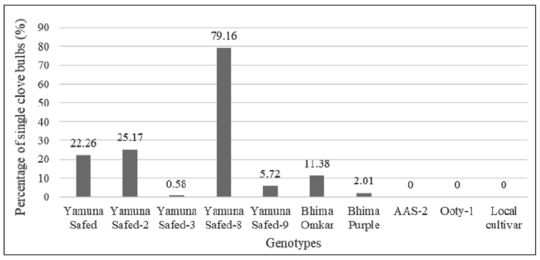


Figure 1. Percentage of single clove bulbs in garlic genotypes

Table 4. Clove characteristics of garlic varieties

Varieties	Number of cloves/bulb			Clove weight (g)			Clove length (cm)			Clove width (cm)			Clove skin thickness (mm)		
	F1	F2	Pooled	F1	F2	Pooled	F1	F2	Pooled	F1	F2	Pooled	F1	F2	Pooled
Yamuna Safed	9.67^{b}	9.10^{c}	9.38^{cd}	1.18^{bc}	0.94^{abc}	1.06^{bcd}	2.57^{de}	2.71^{bc}	2.64^{b}	1.07^{b}	1.01^{b}	1.04^{bc}	0.070	0.063^{bcd}	0.067^{cd}
Yamuna Safed-2	7.50^{b}	3.60^{d}	5.55^{ef}	1.61^{b}	0.74^{abcde}	1.17^{bc}	2.55^{e}	2.51^{bcde}	2.53^{bc}	1.27^{b}	1.13^{ab}	1.20^{b}	0.067	0.060^{cd}	0.064^{cd}
Yamuna Safed-3	12.67^{b}	16.27^{a}	14.47^{ab}	1.10^{bc}	0.72^{bcde}	0.91^{bcd}	2.90^{bc}	3.06^{a}	2.98^{a}	1.04^{b}	0.92^{b}	0.98^{c}	0.058	0.060^{cd}	0.059^{cde}
Yamuna Safed-8	1.67^{c}	3.95^{d}	2.81^{f}	4.60^{a}	1.08^{a}	2.84^{a}	3.09^{ab}	2.61^{bcd}	2.85^{a}	2.07^{a}	1.25^{a}	1.66^{a}	0.064	0.064^{bc}	0.064^{cd}
Yamuna Safed-9	8.7^{b}	4.07^{d}	6.38^{e}	0.97^{bc}	0.59^{de}	0.78^{bcde}	2.83^{bcd}	2.36^{de}	2.59^{b}	1.17^{b}	1.05^{ab}	1.11^{bc}	0.064	0.035^{e}	0.050^{e}
Bhima Omkar	9.57^{b}	5.63^{d}	7.60^{de}	0.88^{bc}	0.61^{cde}	0.74^{cde}	2.66^{cde}	2.52^{bcde}	2.59^{b}	1.08^{b}	1.07^{ab}	1.07^{bc}	0.063	0.051^{d}	0.057^{de}
Bhima Purple	9.4^{b}	5.67^{d}	7.53^{de}	0.79^{bc}	0.61^{cde}	0.70^{de}	2.45^{e}	2.27^{e}	2.36^{cd}	1.10^{b}	1.02^{b}	1.06^{bc}	0.065	0.065^{bc}	0.065^{cd}
AAS-2	19.40^{a}	14.27^{ab}	16.83^{a}	0.47^{c}	0.42^{e}	0.44^{e}	2.11^{f}	2.49^{cde}	2.30^{d}	0.70^{c}	0.63^{c}	0.66^{d}	0.070	0.073^{b}	0.071^{c}
Ooty-1	11.77^{b}	12.40^{b}	12.08^{bc}	1.48^{b}	0.91^{abcd}	1.20^{b}	3.22^{a}	2.72^{bc}	2.97^{a}	1.24^{b}	1.10^{ab}	1.17^{b}	0.078	0.096^{a}	0.087^{b}
Local cultivar	10.17^{b}	16.50^{a}	13.33^{b}	1.43^{b}	0.98^{ab}	1.21^{b}	2.98^{ab}	2.80^{ab}	2.89^{a}	1.27^{b}	1.06^{ab}	1.16^{b}	0.089	0.097^{a}	0.093^{a}
CD (0.05)	5.225	2.854	2.861	0.830	0.346	0.432	0.27	0.31	0.20	0.25	0.22	0.16	NS	0.012	0.012

Highest clove weight was recorded in the local cultivar (1.21 g) and Ooty-1 (1.20 g), apart from Yamuna Safed-8 (2.84 g) which failed in clove differentiation. Though genotype AAS-2 was superior in number of cloves per bulb, the individual clove weight was as low as 0.44 g, which is the characteristic feature of this Karnataka genotype.

The clove lengths observed in Yamuna Safed-3, Ooty-1 and the local cultivar were 2.98 cm, 2.97cm and 2.89 cm respectively. Clove width was highest in Yamuna Safed-8 because it failed in clove differentiation and formed lower number of cloves per bulb. The clove width of Ooty-1 was 1.17cm and was on par with all others except Yamuna Safed-3 and AAS-2 (Table 4). Mishra and Vikram (2017) reported the greatest length and width of garlic clove in Yamuna Safed-3 (2.93 cm and 1.04 cm respectively) under Allahabad agro-climatic conditions. The local cultivar recorded high skin thickness of 0.093 mm.

Yield is a complex character influenced by the varietal characters and the environmental conditions where the plant was grown. The genotype Yamuna Safed-3 recorded the highest cured yield (1.19 kg/ $2m^2$ and 5.96 t/ha) followed by local cultivar (0.90 kg/2 m^2 and 4.48 t/ha) and Ooty-1 (0.89 kg/2 m^2 and 4.47 t/ha) (Table 3), (Fig 2). Though the bulb weight of the local cultivar was on par with Yamuna Safed-3 (15.66 g and 15.31 g respectively), the yield per plot of local cultivar was lower than Yamuna Safed-3. This may be because of the poor field survival of the local cultivar (71.96 %) than Yamuna Safed-3 (96.00 %) (Table 1). The genotype AAS-2 expressed its salient morphological characters in the present agro ecological situation, but the consumer acceptability was too low because of its small sized clove (0.44 g).

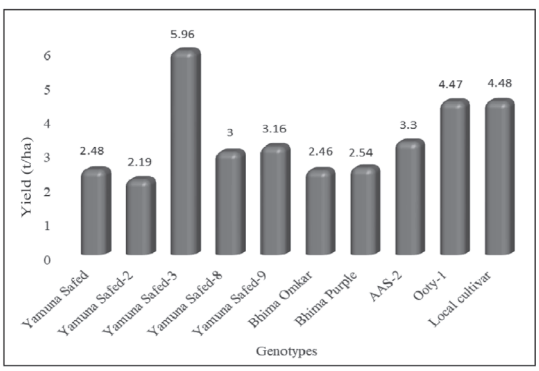


Figure 2. Yield of garlic varieties

Umamaheswarappa et al. (2014) noted that the variety Yamuna Safed-3 recorded a high total yield (6.15 t/ha) and marketable yield (5.23 t/ha) in an experiment conducted under central dry zone of Karnataka. Mishra and Vikram (2017) reported the yield of Yamuna Safed-3 as 10.19 t/ha under Allahabad agro-climatic conditions, whereas, it was 5.80 t/ha under subtropical environment of Jammu (Kumar et al., 2015). Chadha (2003) also stated that Yamuna Safed-3 had the potential to produce big bulbs in the southern hills of the country. In the present study also Yamuna Safed-3 was superior in equatorial diameter, polar diameter, bulb weight, clove length and yield, and recorded a yield of 5.96 t/ha.

Correlation between biometric characters of garlic plant at two months after planting and bulb yield per plant was studied (Table 5). The fresh bulb weight per plant showed highly significant positive correlation with characters like neck thickness (0.665) and plant height (0.557), and a significant positive correlation with number of leaves per plant (0.364). This is in conformity with the findings of Selvaraj et al. (1997) who reported that neck diameter was positively correlated with yield. It was also concluded that higher yield is correlated with greater plant height and number of leaves per plant (Umamaheswarappa et al., 2014).

Table 5. Correlation between biometric plant characters and fresh bulb weight in garlic varieties

	Plant height	No. of leaves	Neck thickness	Fresh bulb weight	Yield
Plant height	1				
No. of leaves	0.748**	1			
Neck thickness	0.788**	0.745**	1		
Fresh bulb weight	0.557**	0.364*	0.665**	1	
Yield	0.566**	0.362*	0.528**	0.841**	1

Note: * denotes Pearson correlation is significant at the 0.05 level
** denotes Pearson correlation is significant at the 0.01 level

Table 6. Correlation between yield characters and fresh bulb weight in garlic varieties

	Equatorial diameter	Polar diameter	No of cloves per bulb	Clove length	Clove width	Clove weight	Fresh bulb weight	Yield per plot
Equatorial diameter	1							
Polar diameter	0.525**	1						
No. of cloves per bulb	0.596**	-0.199	1					
Clove length	0.419*	0.804**	-0.364*	1				
Clove width	-0.299	0.354	-0.829**	0.558**	1			
Clove weight	-0.264	0.322	-0.671**	0.472**	0.919**	1		
Fresh bulb weight	0.846**	0.625**	0.322	0.583**	-0.105	-0.069	1	
Yield per plot	0.826**	0.580**	0.326	0.536**	0.003	0.099	0.841**	1

Note: * denotes Pearson correlation is significant at the 0.05 level

** denotes Pearson correlation is significant at the 0.01 level

Among the yield parameters, fresh bulb weight had highly significant positive correlation with equatorial diameter (0.846), polar diameter (0.625) and clove length (0.583) (Table 6). This is in conformity with the reports of Figliuolo et al. (2001), who reported that bulb weight in garlic was correlated more with bulb diameter than bulb height. Islam et al. (2004), Singh et al. (2012) and Sharma et al. (2015) reported that bulb weight was associated with bulb diameter. Agarwal and Tiwari (2009) reported the positive direct effect of bulb weight and clove length on yield.

The genetic constitution of garlic genotypes along with the environmental conditions attributed to the adaptability of the genotypes to the area studied. Observations on yield characters showed that the genotype Yamuna Safed-3 was the better performer among the ten cultivars evaluated under the agro climatic situations of Kanthalloor during the first crop season. The variety Ooty-1 was also a good yielder, and was on par with the local cultivar. The variety AAS-2 recorded highest number of cloves, but the clove size and yield were low. Single clove bulbs were noticed in Yamuna Safed-8, Yamuna Safed-2 and Yamuna Safed, which indicated their poor adaptability during the first crop season in this rain shadow region.

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