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Evaluation of garlic accessions for high yield under The Nilgiris condition

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Abstract
A study was conducted to evaluate seventy two accessions at Horticultural Research Station, Tamil Nadu Agricultural University, The Nilgiris during 2014 - 2016 for high yield under The Nilgiris condition. Significant differences were observed for all the characters studied. The As 72 recorded the highest plant height of 74.42 cm. Maximum number of leaves was recorded in As 30 (7.73 Nos). The longest leaf length was recorded in As 4 (50.09 cm) while the shortest leaf length was observed in As 71 (17.55 cm). As 72 was found to produce broader leaves (2.94 cm), maximum pseudo stem length (40.62 cm) and pseudostem diameter of 4.15 mm. Among the yield parameters maximum average bulb weight was recorded in As 72 (40.78 g) followed by As 11 (38.61 g) and As 4 (37.36 g). As 72 recorded the maximum 10 clove weight of 28.05 g whereas the lowest was recorded in As 57 of 11.46 g. The As 72 recorded the highest yield per plot (4.14 kg), maximum yield per ha of 152.70 q/ha and marketable yield of 139.20 q/ha.

Keywords: Garlic accessions, high yield under, The Nilgiris condition

Introduction
Garlic (*Allium sativum* L.) is an important bulb crop next to onion. The cloves of garlic bulb are used in flavoring of various vegetarian and non-vegetarian dishes. The significance of this spice is increasing owing to its wide range of medicinal properties (Chanchan *et al.*, 2014) [2]. Garlic is considered as one of the most important species in the family Alliaceae. It is a diploid species (2n=2=16) cultivated since 3000 years B.C. (McCollum, 1987) [8].
India ranks second with an area of 2.02 lakh ha and the production of 14.25 lakh MT (Source: FAO website). In India, Madhya Pradesh is the leading state in area (81170 ha) and production (4.24 lakh MT), whereas maximum productivity is in West Bengal (11.94 tonnes ha^{-1}). In Tamil Nadu, garlic is cultivated in area of 510 hectares with a production of 2890 MT and a productivity of 5.67 tonnes per hectare. The average productivity in India is low (5.69 t ha^{-1}) compared to other countries (www.nhrdf.com).

Materials and Methods
The present investigation was carried out during the year 2014-2016 to study the *per se* performance of garlic accession for high yield under Nilgiris condition. The experiment was conducted in Horticultural Research Station, TNAU, The Nilgiris which is located at 11.4025'N Latitude, 76.735' E Longitude and at an Altitude of 2635 m above Mean Sea Level. The mean annual rainfall of The Nilgiris is 1632 mm. The average maximum and minimum temperature is 26.0ºC and 2 ºC respectively. The average relative humidity is 75 per cent. The experiment was laid out in a Randomized Block Design (RBD) with seventy two accession replicated thrice. The garlic bulbs was sown in the plot area of 1 m^2 and spacing of 15 x 10 cm. In each replication five plants were selected for recording biometrics observations on plant height (cm), number of leaves, leaf length(cm), leaf width(cm), pseudostem length (cm), pseudostem diameter (cm), equatorial diameter (cm), polar diameter (mm), average bulb weight (g). Number of cloves, 10 clove weight, days to 50% neck fall, days to harvest, plot yield, total yield (q/ ha) and marketable yield (q/ ha). The data generated during the course of study was subjected to statistical analysis as prescribed by Panse and Sukhatme (2000) [9].

Results and Discussion
The vegetative growth characters recorded in terms of plant height (cm), number of leaves, leaf length (cm), leaf width (cm), Pseudostem length (cm) and Pseudostem diameter (cm)

are very much important as they play a key role in deciding the ultimate crop yield. The results indicated significant variation among the species for all the characters (Table 1).

Table 1: Evaluation of Garlic accession for vegetative characters under The Nilgiris condition

Accession	Plant height (cm)	No. of leaves	Leaf length (cm)	Leaf width (cm)	Pseudostem length (cm)	Pseudostem Diameter (cm)
As 1	68.98	6.25	47.32	2.41	33.39	2.90
As 2	70.15	5.51	46.64	1.80	30.98	2.70
As 3	69.77	5.91	47.22	2.32	31.03	3.30
As 4	69.03	6.45	50.09	2.23	25.74	2.35
As 5	69.97	6.67	45.81	2.36	32.49	2.60
As 6	68.36	6.67	43.67	2.64	32.59	2.70
As 7	70.16	5.76	45.06	2.75	33.28	3.35
As 8	70.33	6.51	48.15	2.31	33.62	3.40
As 9	69.03	6.71	39.26	2.45	33.21	3.10
As 10	70.80	6.49	45.11	2.70	30.63	3.08
As 11	71.27	6.62	46.68	2.54	32.75	3.60
As 12	69.36	6.69	35.83	2.17	30.75	3.35
As 13	71.14	6.62	35.68	2.67	28.48	3.55
As 14	69.83	6.45	41.42	2.49	32.46	3.55
As 15	70.76	6.50	40.43	2.64	32.50	2.50
As 16	67.48	6.60	39.62	2.66	25.73	3.10
As 17	59.04	5.55	33.30	2.30	28.49	3.05
As 18	70.24	6.77	35.65	2.73	31.66	2.85
As 19	59.59	5.76	38.67	2.79	30.55	2.60
As 20	70.67	6.63	37.52	2.37	33.66	3.25
As 21	63.02	6.49	40.36	2.45	34.52	3.00
As 22	70.36	6.51	38.06	2.32	29.55	3.06
As 23	65.97	5.56	38.17	2.40	27.53	3.10
As 24	68.07	6.35	36.08	2.29	31.40	3.30
As 25	69.94	5.60	34.11	2.34	34.75	3.10
As 26	70.32	6.60	43.71	1.80	35.55	2.50
As 27	71.09	6.37	41.88	2.68	33.30	2.45
As 28	67.83	7.62	39.09	2.24	33.51	3.00
As 29	70.51	6.22	36.57	2.40	32.95	3.50
As 30	65.11	7.73	33.63	2.25	33.10	3.21
As 31	66.62	6.35	35.69	2.73	31.75	3.15
As 32	61.33	6.36	36.84	2.69	33.04	3.25
As 33	62.18	7.07	39.91	2.45	34.18	3.20
As 34	63.81	6.66	37.76	2.58	32.77	3.10
As 35	64.54	7.39	36.70	2.44	33.23	3.25
As 36	70.30	6.58	37.36	2.68	27.01	3.10
As 37	56.07	6.74	37.94	2.16	28.90	2.50
As 38	60.30	6.31	33.67	2.34	30.91	3.10
As 39	64.70	6.48	36.35	2.47	32.49	2.65
As 40	67.57	6.65	35.63	2.31	32.25	2.55
As 41	54.41	6.31	37.39	2.46	33.67	2.70
As 42	51.71	6.33	35.61	2.27	31.47	3.10
As 43	63.50	6.41	35.98	2.56	32.30	3.10
As 44	62.15	5.94	34.82	2.51	31.42	3.15
As 45	63.50	7.24	38.82	2.68	25.76	2.70
As 46	67.22	6.40	38.87	2.51	32.69	3.15
As47	62.45	5.52	39.13	2.60	33.68	3.10
As 48	63.22	5.58	37.23	2.45	32.50	3.15
As 49	63.90	6.62	35.74	2.79	31.41	3.00
As 50	63.10	6.87	33.28	2.45	28.32	2.50
As 51	67.52	6.64	37.44	2.65	27.35	3.05
As 52	63.97	6.55	34.01	2.63	27.64	2.55
As 53	71.58	6.60	38.02	2.48	26.60	2.55
As 54	64.02	6.14	34.69	2.73	26.07	2.70
As 55	68.59	7.28	37.22	2.30	24.60	3.10
As 56	66.98	6.24	35.96	2.67	28.23	3.15
As 57	61.56	7.18	35.54	2.46	32.71	3.15
As 58	64.10	5.46	45.30	2.67	32.40	2.80
As 59	66.97	5.36	35.52	2.29	31.50	3.05
As 60	64.07	6.60	36.68	2.56	32.25	3.10
As 61	62.73	6.62	35.73	2.60	28.72	2.35
As 62	48.31	7.36	33.56	2.45	28.40	3.05
As 63	68.12	6.35	31.33	2.78	27.37	2.50

As 64	67.69	6.58	30.77	2.60	26.91	3.05
As 65	65.93	6.35	33.68	2.79	32.41	3.15
As 66	45.68	6.41	33.72	2.68	33.34	3.10
As 67	67.52	5.45	33.54	2.70	31.39	3.15
As 68	68.02	7.39	31.82	2.73	33.57	3.05
As 69	67.06	6.01	33.77	2.73	28.42	2.55
As 70	68.08	5.58	33.62	2.56	27.52	3.10
As 71	68.20	5.41	17.55	2.40	35.48	2.45
As 72	74.42	7.31	46.28	2.94	40.62	4.15
Me an	65.87	6.43	37.84	2.50	31.17	3.00
SE d	4.27	0.364	2.19	0.182	2.02	0.172
Cd	8.45	0.72	4.34	0.36	3.99	0.34

The plant height was ranged from 45.68 to 74.42 cm and it was significantly higher in the As 72 (74.42 cm) followed by As 53 (71.58 cm) and As 13 (71.14 cm). The lowest plant height was recorded in As 53 (45.68 cm). Plant height is a good indicator of plant vigour and genetic potentiality of the genotype, which may contribute towards the higher productivity. Variability for plant height among the different species was mainly due to genetic nature and environmental nature. The results were in agreement with the results of Raju Panse *et al.,* 2013 [10].

Leaves are the important functional units for photosynthesis, which greatly influence the growth and yield. The data on number of leaves recorded was maximum in As 30 (7.73 Nos) followed by As 28 (7.62 Nos) and As 35 (7.39 Nos) and minimum number of leaves was noticed in As 59 (5.36 Nos). Significant difference in leaf number among garlic accessions also reported by Kumar and Prasad. 2015. The longest leaf length was recorded in As 4 (50.09 cm) while the shortest leaf length in As 71 (17.55 cm). As 72 was found to produce broader leaves (2.94 cm) and As 2 (1.80 cm) with narrower leaves. These findings are in agreement with Kohli and Prabal (2000) [5] and Sengupta *et al.,* (2007) [11]. Among the accessions As 72 had shown a greater pseudostem length of 40.62 cm followed by As 71 of 35.48 cm. With regard to maximum pseudostem diameter was recorded in As 72 of 4.15 cm and minimum was observed As 61 of 2.35 cm. The findings of Jogdande *et al.,* (2004) [4] are similar to that of the present findings.

The yield contributing characters are presented in Table 2. Significant deviations were noticed among the accessions pertaining to the equatorial and polar diameter which ranged from 26.02 – 41.84 cm and 27.61- 46.95 mm respectively. In both the cases the accession As 72 performed better as compared to other entries. The length and width of the garlic bulb as precisionally indicated as polar and equatorial diameter of the bulb decides the economic size and an important parameter to study for various accession in garlic pertaining to crop improvement. Variation in bulb size have also been confirmation with the studied Islam *et al.,* (2004) [3] and Kumar and Prasad. 2015 in garlic

Table 2: Evaluation of Garlic accession for Yield characters under The Nilgiris condition

Accession	Equatorial Diameter (mm)	Polar diameter (mm)	Average bulb wt (g)	No. of cloves	10 clove wt(g)	Days to 50% neck fall	Days to harvest	Per plot yield	Yield/ha (q/ha)	Marketable Yield (q/ha)
As 1	38.59	40.84	37.20	15.79	24.50	94.00	122.50	2.24	93.65	84.90
As 2	36.90	41.47	35.66	11.24	23.68	100.50	120.00	2.05	85.55	77.25
As 3	35.96	37.21	35.37	14.13	19.88	85.50	123.50	2.73	99.00	87.85
As 4	36.67	37.86	37.36	17.58	19.20	89.50	120.00	2.19	94.20	84.70
As 5	37.63	38.75	29.74	12.69	23.64	82.50	120.00	2.25	75.10	63.25
As 6	35.95	36.75	28.59	12.61	16.86	99.50	120.00	2.17	83.15	73.75
As 7	35.17	39.64	32.27	19.44	15.56	89.50	120.00	2.22	82.35	73.70
As 8	34.89	36.76	34.57	15.73	16.50	100.50	122.50	2.24	87.55	74.00
As 9	36.63	38.45	32.13	14.50	20.52	101.00	120.00	2.52	76.00	72.50
As 10	37.93	38.68	30.98	13.66	20.51	96.00	120.00	2.54	85.40	78.10
As 11	37.64	39.75	38.61	16.43	20.57	85.50	121.00	3.46	112.95	83.45
As 12	36.58	38.46	30.44	11.45	22.50	99.50	120.00	2.44	102.35	88.10
As 13	35.42	36.39	33.95	12.34	23.48	104.50	120.00	2.71	98.45	92.15
As 14	38.04	38.46	33.76	14.45	23.51	95.50	120.00	3.54	109.95	82.65
As 15	35.85	37.64	35.02	13.46	21.41	90.50	120.00	2.76	93.55	83.85
As 16	35.67	37.52	37.05	13.41	24.68	100.50	120.00	2.53	85.90	77.30
As 1 7	26.02	27.61	25.96	13.22	19.22	109.50	120.00	2.44	53.40	47.10
As 18	36.52	37.61	25.44	14.59	22.64	95.50	120.00	2.63	92.50	83.05
As 19	28.97	30.26	23.99	12.61	21.50	97.50	120.00	2.53	93.80	86.55
As 20	30.93	31.64	29.47	12.58	22.71	97.00	120.00	3.52	95.05	83.75
As 21	31.38	31.84	25.67	13.56	23.58	88.00	120.00	2.44	88.60	72.85
As 22	30.00	31.24	26.54	14.69	19.88	93.00	122.50	2.42	77.65	67.80
As 23	36.27	36.76	31.42	13.73	20.66	103.50	120.00	2.58	83.15	73.95
As 24	38.92	39.38	37.51	12.84	20.36	86.00	120.00	2.52	97.80	84.80
As 25	35.94	39.49	30.30	13.62	24.29	91.00	120.00	2.43	84.10	73.15
As 26	37.62	39.38	35.42	13.82	25.70	96.00	120.00	2.57	87.95	75.35
As 27	36.37	40.49	36.44	12.78	26.76	102.00	120.00	2.74	86.60	83.45
As 28	36.76	37.61	31.81	16.29	19.53	103.00	120.00	2.69	98.10	86.00
As 29	36.97	43.81	27.98	15.67	21.63	102.00	120.00	2.72	105.50	92.55
As 30	35.97	36.39	28.79	13.46	22.80	106.50	120.00	2.53	87.95	82.75

As 31	35.67	38.51	34.48	18.65	19.72	98.50	120.00	2.52	95.05	98.20
As 32	34.02	35.38	29.59	16.40	19.94	96.50	120.00	2.23	84.25	77.70
As 33	35.54	38.72	30.59	12.58	22.54	98.50	120.00	2.68	77.05	67.15
As 34	36.76	37.64	30.72	14.74	24.55	99.00	125.00	2.50	84.90	81.90
As 35	37.32	39.42	33.87	16.75	21.49	111.00	130.00	3.31	120.15	97.60
As 36	35.59	37.60	30.37	12.69	23.71	104.50	120.00	2.63	97.95	94.20
As 37	34.91	35.43	29.20	17.53	21.77	100.50	120.00	2.51	100.95	86.00
As 38	39.38	41.38	34.56	13.86	24.34	95.50	118.50	2.65	87.25	84.20
As 39	37.62	39.49	33.43	13.67	24.61	108.00	120.00	2.48	86.05	74.80
As 40	36.59	39.38	28.22	13.57	21.70	104.50	120.00	2.87	78.80	74.90
As 41	36.82	44.49	30.88	13.48	23.48	103.50	120.00	2.44	98.05	93.40
As 42	36.44	40.29	28.79	13.59	24.60	108.50	120.00	2.84	78.55	68.85
As 43	36.32	38.37	31.66	11.83	24.69	111.00	120.00	2.45	101.90	93.40
As 44	37.03	39.64	31.44	14.90	22.66	108.00	120.00	2.55	94.55	85.35
As 45	39.18	38.76	28.78	13.63	22.28	108.00	120.00	2.74	84.05	77.85
As 46	37.67	38.38	29.54	15.67	21.55	107.00	120.00	2.46	102.20	95.60
As 47	38.43	37.49	33.67	14.66	22.17	94.50	120.00	2.76	74.80	69.40
As 48	38.40	40.51	30.62	14.45	22.50	97.50	120.00	2.46	94.45	87.10
As 49	36.96	39.61	33.63	15.82	23.68	100.00	120.00	2.84	83.25	74.80
As 50	34.95	40.29	31.47	13.48	23.58	103.00	120.00	2.86	84.00	78.25
As 51	36.17	39.38	29.37	14.95	23.84	95.50	120.00	2.75	77.80	74.30
As 52	34.46	37.72	29.48	15.63	21.47	112.50	120.00	2.43	79.95	74.05
As 53	35.83	38.38	34.88	17.43	22.52	108.00	120.00	2.60	85.90	83.30
As 54	32.08	33.64	31.42	12.30	23.82	107.50	120.00	2.70	84.80	84.35
As 55	35.55	37.43	25.91	11.33	22.55	103.00	120.00	2.63	84.90	75.20
As 56	35.51	39.91	31.30	13.47	22.51	95.50	120.00	2.76	86.75	77.50
As 57	27.64	33.26	30.68	17.68	11.46	99.00	120.00	2.52	75.45	66.70
As 58	27.05	29.83	26.70	15.42	16.83	99.00	120.00	2.53	76.85	65.90
As 59	31.38	31.42	26.50	18.83	15.50	100.00	120.00	2.56	65.70	56.05
As 60	33.59	34.43	28.70	18.38	17.43	108.00	120.00	2.65	63.00	54.40
As 61	30.97	31.37	27.65	17.63	16.66	99.00	120.00	2.44	67.95	54.80
As 62	32.24	34.42	23.94	16.85	12.72	97.50	120.00	2.43	55.95	49.40
As 63	33.20	34.38	22.63	14.49	15.69	99.50	120.00	2.64	62.15	55.70
As 64	32.98	33.44	24.62	16.35	14.59	103.00	120.00	2.55	73.75	65.20
As 65	32.02	32.64	26.66	20.26	14.55	99.50	120.00	2.91	72.60	64.00
As 66	32.51	34.26	24.18	16.68	14.67	103.00	120.00	2.49	83.95	72.85
As 67	32.29	33.72	24.31	17.85	13.62	108.50	120.00	2.76	85.10	76.10
As 68	29.13	30.37	26.70	21.65	13.50	106.50	120.00	2.63	72.55	64.20
As 69	31.64	33.75	26.58	18.31	15.89	101.00	120.00	2.71	74.25	59.65
As 70	31.67	34.26	28.50	17.79	17.44	108.00	120.00	2.58	74.05	65.30
As 71	30.23	31.84	27.46	19.83	14.51	100.00	120.00	2.59	83.60	72.50
As 72	41.84	46.95	40.78	19.65	28.05	101.50	140.00	4.14	152.70	139.20
Mean	35.00	37.03	30.61	15.10	20.75	99.91	120.63	2.63	86.69	77.50
SE d	2.27	2.11	2.02	1.11	1.19	6.54	8.76	0.15	5.74	5.75
Cd	4.95	4.16	3.96	2.2	2.37	12.98	17.39	0.29	11.35	11.36

Among the garlic accession, maximum average bulb weight was recorded in As 72 (40.78 g) followed by As11 (38.61 g) and As 4 (37.36 g) and lowest average bulb weight was recorded in As 63 (22.63 g). Variations in bulb weight of garlic for different lines are in accordance with the finding of Agarwal and Tiwari (2013). High variation in number of cloves per bulb ranged from 11.33 to 28.05 nos. As 68 recorded the maximum number of cloves 21.65 nos followed by As 65 (20.26 nos) and As 7 (19.44 nos) whereas minimum number of cloves per bulb was noticed in As 55 (11.33 nos). As 72 recorded the maximum 10 clove weight of 28.05 g whereas the lowest was recorded in As 57 of 11.46 g. These results are in agreement with the line of Alam *et al.,* 2010. With respect to days to 50 % neck fall earliest was recorded in As 5 (82.50 days) and maximum entries recorded 120 days for harvest.

With respect to the yield parameters significant differences were observed in Yield per plot, total yield (q/Ha) and Marketable yield (q/Ha).The yield per plot ranged from 2.05 to 4.14 kg/plot. The entry As 72 recorded the highest yield per plot of 4.14 kg and lowest yield per plot of 2.05 kg was observed in As 2. The different accession of garlic were studied pertaining to the total yield (q/ha).The As 72 recorded maximum yield per ha of 152.70 q/ha followed by As 34 of 120.15 q/ha and As 11 of 112.95 q/ha. Marketable yield ranged from 47.10 to 139.20 q/ha. Pooled mean has also revealed that the maximum marketable yield was recorded in As 72 of 139.20 q/ha followed by As 31 of 98.20 q/ha and As 46 of 95.60 q/ha whereas lowest marketable yield was observed in As 17 of 47.10 q/ha. The perusal of results revealed that accession with higher yield maintained good plant growth as number of leaves per plant, leaf width which might have improved their photosynthetic efficiency resulting into better bulb yield. The line with the finding of Umamaheswarappa *et al.,* 2014 [12]. It could be concluded from the present investigation that out of seventy two accession evaluated As 72 were found to be superior in vegetative and yield parameters for garlic under Nilgiri condition.

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