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Performance of ashwagandha (*Withania somnifera* L.) promising lines on growth, yield, quality and productivity

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Abstract

The present investigation entitled “Studies on growth, yield, productivity and quality of promising lines of ashwagandha (*Withania somnifera* L.)” was undertaken to identify superior lines based on growth, yield, productivity and quality characters for root yield and yield components of ashwagandha. Fifteen (15) promising lines were sown in a Randomized Block Design with three replications during late *kharif*, 2021 at P.G. Research Block, College of Horticulture, Rajendranagar, Hyderabad, Sri Konda Laxman Telangana State Horticultural University. The analysis of variance (ANOVA) of RBD revealed highly significant differences among the promising lines for all the twenty-eight characters studied. The promising line IC-286632 was significantly superior for yield and yield attributing characters *i.e.*, root diameter (2.19 cm), fresh root weight of the plant (33.06 g), fresh root weight per plot (0.99 kg), fresh root weight per hectare (16.52 q), dry root yield per plant (14.51 g), dry root yield per plot (0.44 kg), dry root yield per hectare (7.26 q). The promising line NMITLI-101 was significantly superior for plant height (111.39 cm), leaf length (12.44 cm), fresh leaf weight per plant (213.02 g), dry leaf weight per plant (63.21 g) and main root length (24.67 cm). The promising line RAS-65 was found to be superior for berry diameter (0.75 cm), number of seeds per berry (41.09), seed yield per plant (9.64 g), seed yield per plot (0.29 kg) and seed yield per hectare (4.81 q). The promising line Poshita recorded highest starch content (15.39%) and high starch: fiber ratio (0.48). CIM-Chetak recorded high alkaloid content (0.45%) which was on par with IC-286632(0.43%). Considering, the mean performances, seven promising lines IC-286632, NMITLI-101, NMITLI-118, RAS-65, CIM-CHETAK, MWS-218 along with check POSHITA with high yield and quality components were found to be superior and may be utilized further in crop improvement programmes.

Keywords: Ashwagandha, promising lines, growth, yield, quality, productivity, mean performance

Introduction

Withania somnifera L. vernacularly called as Ashwagandh, Indian Ginseng, Ashgandh, Poison gooseberry, Winter cherry (Deshpande, 2005) [3]. It belongs to the family Solanaceae with chromosome number $2n = 48$. Ashwagandha originated in the Mediterranean region of North Africa, North Western and Central India (Srivastava *et al.*, 2017) [18]. Ashwagandha is a drought-tolerant perennial plant (Ali *et al.*, 1997) [11] that grows well in dry and sub-tropical areas with well-drained, sandy loam or light red soils with pH of 7.5 to 8.0 having an average rainfall of 600-750 mm (Kukreti *et al.*, 2013) [7]. It is a cash crop in fields where more profitable plants will not be suitable to be grown (Moharana *et al.*, 2020) [14]. The plant is 30-150 cm tall, an erect evergreen shrub which has stellate tomentose branches. Leaves are simple, alternate, bearing cymose cluster of 5-25 inconspicuous pale green bisexual flowers in their axil. Fruit berry in a persistent calyx, 5 mm in diameter, green when unripe, orange-red when mature. The plant has fleshy taproot and thickness ranges from 0.2 - 4.0 cm, with buff to grey-yellow outer colour with longitudinal wrinkles.

The main alkaloids are withanolids, somniferine, somniferinine, somnine, withananine, pseudowithananine and asomnine (Covello and Ciampa, 1960) [2]. At present, more than 12 alkaloids and 40 withanolides have been isolated and reported from aerial parts, roots and berries of this plant. The root is the economic part of ashwagandha. According to the research findings, the content of alkaloid in the Indian roots varied between 0.13% and 0.31%. The medicinal properties of ashwagandha roots are enormous. In Ayurveda it is mainly indicated in the treatment of shosha (malnutrition), shukra dosa (defects of semen), vata-vyadhi (nervine diseases), unmada (mental diseases) and epilepsy.

Roots are having anti-aging property (Savitha *et al.*, 2009)^[17]. This quality herb possesses therapeutic value against a number of ailments such as arthritis, asthma, mental diseases, infections, fever, anxiety, tuberculosis, impotency and cancer (Mirjalili *et al.*, 2009)^[12]. The whole plant but especially the leaves and the root bark are abortifacient, adaptogen, antibiotic, antifungal, aphrodisiac, deobstruent, narcotic and strongly sedative. Seeds are diuretic in nature.

Investigations have revealed that ashwagandha serve as a potential inhibitor against M pro of SARS-CoV-2 to combat COVID-19 and may have an antiviral effect on nCoV. (Tripathi *et al.*, 2021)^[19]. The plant is referred as Indian ginseng owing to its wide spectrum applications in medicine and expansion of area has vast scope due to spread of diseases and viruses like Covid-19. Therefore, there is an urgent need to identify suitable and high yielding variety from existing promising lines in terms of growth, yield, productivity and quality and can be proposed for further advanced varietal trials for their yield stability and also can be evaluated by multi-location testing for their yield and quality potential.

Materials and Methods

The present investigation for growth, yield, quality and productivity traits in ashwagandha was conducted during late kharif season, 2021 in a completely Randomized Block Design with 15 ashwagandha promising lines as treatments at college of horticulture, Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, Hyderabad. Each treatment was randomly replicated thrice. The experimental material comprised of 15 promising lines of ashwagandha. The experimental material was collected from the Ph.D study carried out for two seasons (*Kharif*, 2018 and *Rabi*, 2018-2019) at COH, Rajendranagar from Department of Plantation, Spices, Medicinal and Aromatic Crops. The previous source of procurement is from DMAPR, Anand, Gujarat; CIMAP, Lucknow, Uttar Pradesh and PDKV, Akola, Maharashtra. Plants of each promising line were planted at a spacing of 40 x 50 cm in a plot of 3.0 m x 2.0 m. Standard cultural practices were adopted to ensure a healthy crop growth. Necessary prophylactic plant protection measures were taken up to safe guard the promising lines from pests and diseases. All the promising lines were studied systematically to identify best promising lines for the growth, yield, productivity and quality in ashwagandha. The experimental material was evaluated for 28 characters *viz.*, Plant height (cm), number of branches per plant, leaf length (cm), leaf width (cm), days to flower initiation, days to fruit formation, days to root harvest, fresh leaf weight per plant (g), dry leaf weight per plant (g), number of berries per plant, berry diameter (cm), number of seeds per berry, seed yield per plant (g), seed yield per plot (kg), seed yield per hectare (q), main root length (cm), diameter of root (cm), number of secondary roots per plant, fresh root weight per plant (g), fresh root weight per plot (kg), fresh root weight per hectare (q), dry root yield per plant (g), dry root yield per plot (kg), dry root yield per hectare (q), starch content estimation (%), crude fiber content estimation (%), starch and fiber ratio, total alkaloid content (%). Crude fiber was estimated by the modified method of Maynard (1970)^[10]. Starch content was estimated by the method of Mc Cready *et al.* (1950)^[11]. The total alkaloid content was estimated by the method of Mishra (1996)^[13]. Analysis of variance was calculated with the method suggested by Panse and Sukhatme (1985)^[15].

Results and Discussion

The results obtained during the investigation with respect to various parameters *viz.*, Plant height (cm), number of branches per plant, leaf length (cm), leaf width (cm), days to flower initiation, days to fruit formation, days to root harvest, fresh leaf weight per plant (g), dry leaf weight per plant (g), number of berries per plant, berry diameter (cm), number of seeds per berry, seed yield per plant (g), seed yield per plot (kg), seed yield per hectare (q), main root length (cm), diameter of root (cm), number of secondary roots per plant, fresh root weight per plant (g), fresh root weight per plot (kg), fresh root weight per hectare (q), dry root yield per plant (g), dry root yield per plot (kg), dry root yield per hectare (q), starch content estimation (%), crude fiber content estimation (%), starch and fiber ratio, total alkaloid content (%) are discussed as below. In order to evaluate the 15 promising lines, the mean performance for 28 characters was studied and presented in Table 1. The mean performance of the promising lines with respect to the aforesaid characters were statistically significant, suggesting that there is ample scope for selection in different traits for the improvement of ashwagandha.

For growth parameters the range for plant height among promising lines varied from maximum 111.39 cm (NMITLI-101) to minimum 43.61 cm (AKAS-11) with a grand mean of 63.64 cm. The range for number of branches per plant varied from maximum 7.47 (IC-283942) to minimum 3.13 (CIM-Chetak) with a grand mean of 5.33. The mean performance for leaf length varied from maximum 12.44 cm (NMITLI-101) to minimum 7.73 cm (IC-283662) with grand mean of 9.58 cm. The mean performance for leaf width varied from maximum 7.56 cm (NMITLI-118) to minimum 4.03 cm (IC-283942) with a grand mean of 5.14 cm.

For phenological parameters like days to flower initiation minimum number of days to flower initiation 57.67 days were noticed in check line (Poshita) and maximum 124.07 days (CIM-Chetak) with a mean of 76.98 days. Minimum days to berry formation 30.66 days were noticed in RAS-7 and maximum 41.17 days (NMITLI-118) with a grand mean of 36.78 days. Minimum days to root harvest 161.28 days noticed in IC-310595 to maximum 218.02 days (NMITLI-118) with a grand mean of 182.62 days.

Yield and productivity parameters like the mean performance for fresh leaf weight per plant varied from maximum 213.02 g (NMITLI-101) to minimum 36.83 g (Poshita) with a grand mean of 114.25 g. The mean performance for dry leaf weight per plant ranged from maximum 63.21 g (NMITLI-101) to minimum 10.07 g (AKAS-11) with a grand mean of 27.91 g. The mean performance for number of berries per plant varied from maximum 353.00 (RAS-7) to minimum 64.20 (NMITLI-118) with a grand mean of 245.82. The mean performance for berry diameter ranged from maximum 0.75 cm (RAS-65) to minimum 0.57 cm (IC-310595) with a grand mean of 0.66 cm. Number of seeds per berry varied from maximum 41.09 (RAS-65) to minimum 25.82 (IC-310595) with a grand mean of 35.86. Seed yield per plant varied from maximum 9.64 g (RAS-65) to minimum 2.54 g (NMITLI-118) with a grand mean of 5.94 g. Seed yield per plot varied from maximum 0.29 kg (RAS-65) to minimum 0.08 kg (NMITLI-118) with a grand mean of 0.18 kg. Seed yield per hectare varied from maximum 4.81 q (RAS-65) to minimum 1.26 q (NMITLI-118) with a grand mean of 2.97 q. The main root length of promising lines of ashwagandha varied from maximum 24.67 cm (NMITLI-101) to minimum 10.35 cm

(IC-283662) with a grand mean of 15.47 cm. The main root diameter of promising lines of ashwagandha varied from maximum 2.19 cm (IC-286632) to minimum 0.97 cm (AKAS-11) with a grand mean of 1.55 cm. The mean values for number of secondary roots per plant varied from maximum 6.04 (MWS-218) to minimum 1.33 (Poshita) with a grand mean of 4.03. The mean performance of fresh root weight per plant varied from maximum 33.06g (IC-286632) to minimum 6.47g (AKAS-11) with a grand mean of 17.90g. The mean performance of fresh root weight per plot varied from maximum 0.99 kg (IC-286632) to minimum 0.19 kg (AKAS-11) with a grand mean of 0.54kg. The mean performance of fresh root weight per hectare varied from maximum 16.52q (IC-286632) to minimum 3.24 q (AKAS-11) with a grand mean of 8.95q. The mean values for dry root yield per plant ranged from maximum 14.51g (IC-286632) to minimum 4.04 g (IC-283942) with a grand mean of 8.50 g. The mean performance for dry root yield per plot ranged from maximum 0.44 kg (IC-286632) to minimum 0.12 kg (AKAS - 11 and IC-283942) with a grand mean of 0.26 kg. The mean values for dry root yield per hectare ranged from maximum 7.26 q (IC-286632) to minimum 2.02 q (IC-283942) with a grand mean of 4.25 q.

Quality parameters like Starch content in ashwagandha promising lines ranged from 15.39 % (Poshita) to minimum 10.12 % (IC-283942) with a grand mean of 12.72%. Crude fiber content in ashwagandha promising lines ranged from maximum 42.17 % (NMITLI -118) to minimum 23.86% (AKAS-10) with a grand mean of 34.92%. The mean values for starch fiber ratio ranged from maximum 0.48 (Poshita) to minimum 0.28 (IC-283942) with a grand mean of 0.37. The total alkaloid content of promising lines ranged from

maximum 0.45 % (CIM-Chetak) to minimum 0.28 % (IC-283942) with a grand mean of 0.36 %.

The necessity to study the mean performances of plant characters is to reveal the potentiality of the promising lines taken up for research work which aims to open new gate way for studying the characters in depth which provides a way for exploring the promising lines for further studies. Eminent work has been done on different genotypes of ashwagandha and mean performances has been recorded by Laxminarayana and Mukund (2003) [9], Kumar *et al.* (2007) [8], Polaiiah *et al.* (2013) [16], Gami *et al.* (2015) [4], Gulati *et al.* (2017) [5], Venugopal *et al.* (2021) [20] and Kujur *et al.* (2021) [6].

The result of mean performance of 15 promising lines for twenty eight characters revealed that the promising line IC-286632 was significantly superior for yield and yield attributing characters *i.e.*, root diameter (2.19 cm), fresh root weight of the plant (33.06 g), fresh root weight per plot (0.99 kg), fresh root weight per hectare (16.52 q), dry root yield per plant (14.51 g), dry root yield per plot (0.44 kg), dry root yield per hectare (7.26 q) and significantly high total alkaloid content. The promising line NMITLI-101 was significantly superior for plant height (111.39 cm), leaf length (12.44 cm), fresh leaf weight per plant (213.02 g), dry leaf weight per plant (63.21 g) and main root length (24.67 cm). The promising line RAS-65 was found to be superior for berry diameter (0.75 cm), number of seeds per berry (41.09), seed yield per plant (9.64 g), seed yield per plot (0.29 kg) and seed yield per hectare (4.81 q). The promising line Poshita recorded highest starch content (15.39%) and high starch:fiber ratio (0.48). CIM-Chetak recorded high alkaloid content (0.45%) which was on par with IC-286632(0.43%).

Table 1: Mean performances of ashwagandha promising lines with respect to various parameters

S.No	Promising line	Plant height (cm)	No. of branches per plant.	Leaf Length (cm)	Leaf Width(cm)	Days to flower initiation	Days to berry formation	Days to root harvest	Fresh leaf weight per plant (g)	Dry leaf weight per plant(g)	Number of berries per plant	Berry diameter (cm)	No. of seeds per berry	Seed yield per plant(g)	Seed yield per plot (kg)
1	AKAS-10	56.91	6.50	9.16	5.08	67.21	37.88	174.64	91.73	27.16	261.00	0.70	40.75	6.88	0.21
2	AKAS-11	43.61	4.40	8.72	5.30	71.47	37.08	176.68	56.17	10.07	337.47	0.66	33.43	5.96	0.18
3	IC-283662	54.66	6.20	7.73	4.15	66.38	34.91	177.11	56.80	11.27	237.93	0.71	37.13	5.90	0.18
4	IC-283942	54.96	7.47	7.81	4.03	65.36	39.84	168.99	91.93	23.59	259.13	0.65	33.71	3.10	0.09
5	IC-286632	55.70	6.40	8.74	4.25	59.47	37.86	189.24	131.16	25.51	287.27	0.66	40.41	8.06	0.24
6	IC-310595	53.38	4.47	8.27	4.44	70.73	36.67	161.28	107.07	17.59	327.53	0.57	25.82	5.14	0.15
7	RAS-7	55.07	5.67	9.21	5.15	60.19	30.66	172.92	132.74	23.47	353.00	0.70	38.23	6.43	0.19
8	RAS-65	45.07	7.30	9.25	4.97	84.17	38.59	189.01	155.84	31.45	246.80	0.75	41.09	9.64	0.29
9	MWS-218	55.02	4.33	9.79	5.17	59.71	32.18	165.15	113.60	19.20	317.47	0.64	29.30	8.95	0.27
10	JA-134	55.05	5.27	8.69	4.21	62.84	37.44	179.43	151.20	35.87	317.80	0.70	36.20	6.98	0.21
11	CIM-CHETAK	93.72	3.13	10.69	5.97	124.07	38.57	204.75	142.48	46.78	78.77	0.60	36.39	3.11	0.09
12	CIM-PRATAP	75.96	4.07	9.88	4.64	79.93	37.57	170.01	58.07	14.83	263.17	0.65	39.64	7.56	0.23
13	NMITLI-101	111.39	5.33	12.44	6.23	104.08	37.35	204.00	213.02	63.21	92.00	0.63	31.11	2.86	0.09
14	NMITLI-118	91.50	5.27	12.41	7.56	121.43	41.17	218.02	175.11	50.51	64.20	0.66	38.96	2.54	0.08
15	POSHITA	52.61	4.20	10.97	6.02	57.67	34.00	188.09	36.83	18.05	243.80	0.66	35.82	6.01	0.18
	Grand mean	63.64	5.33	9.58	5.14	76.98	36.78	182.62	114.25	27.91	245.82	0.66	35.86	5.94	0.18
	S.Em(±)	2.40	0.15	0.59	0.44	2.62	1.10	2.23	3.81	1.26	10.73	0.01	1.76	0.28	0.01
	CV (%)	6.54	4.73	10.74	14.94	5.90	5.17	2.11	5.78	7.82	7.56	3.47	8.52	8.25	8.26
	CD (P=0.05)	6.96	0.42	1.72	1.29	7.60	3.18	6.45	11.04	3.65	31.07	0.04	5.11	0.82	0.02

Table 2: Mean performances of ashwagandha promising lines with respect to various parameters. (Contd.)

S.No	Promising line	Seed yield per hectare (q)	Main root length (cm)	Main root diameter (cm)	No. of secondary roots per plant	Fresh root weight per plant (g)	Fresh root weight per plot (kg)	Fresh root weight per hectare (q)	Dry root weight per plant (g)	Dry root weight per plot (kg)	Dry root weight per hectare (q)	Starch estimation (%)	Crude fiber estimation (%)	Starch : Fiber ratio	Total alkaloid content (%)
1	AKAS-10	3.44	13.52	1.18	4.85	13.82	0.41	6.90	6.75	0.20	3.38	10.58	23.86	0.45	0.29
2	AKAS-11	2.97	11.15	0.97	4.93	6.47	0.19	3.24	4.11	0.12	2.06	11.17	33.06	0.34	0.29
3	IC-283662	2.95	10.35	1.27	3.70	10.13	0.30	5.06	4.39	0.13	2.19	10.41	31.94	0.33	0.33
4	IC-283942	1.54	12.33	1.14	4.58	9.69	0.29	4.85	4.04	0.12	2.02	10.12	36.75	0.28	0.28
5	IC-286632	4.03	18.81	2.19	3.18	33.06	0.99	16.52	14.51	0.44	7.26	14.13	31.41	0.45	0.43
6	IC-310595	2.56	13.09	1.08	3.75	9.75	0.29	4.87	4.19	0.13	2.10	10.72	34.15	0.31	0.33
7	RAS-7	3.21	12.71	1.31	3.81	13.19	0.40	6.59	5.79	0.17	2.89	13.24	32.99	0.40	0.40
8	RAS-65	4.81	15.27	2.11	3.49	28.68	0.86	14.34	13.45	0.40	6.73	13.90	33.33	0.42	0.41
9	MWS-218	4.46	14.56	1.30	6.04	9.70	0.29	4.84	5.64	0.17	2.82	13.89	33.99	0.41	0.35
10	JA-134	3.48	15.96	1.83	4.85	19.65	0.59	9.83	10.33	0.31	5.16	11.93	40.19	0.30	0.36
11	CIM-CHETAK	1.55	18.78	2.10	4.92	28.18	0.85	14.09	13.12	0.39	6.55	14.86	39.24	0.38	0.45
12	CIM-PRATAP	3.78	10.52	1.25	4.40	13.39	0.40	6.69	6.21	0.19	3.10	12.03	36.78	0.33	0.37
13	NMITLI-101	1.43	24.67	2.12	3.51	31.63	0.95	15.82	13.69	0.41	6.85	13.81	41.86	0.33	0.36
14	NMITLI-118	1.26	23.59	1.35	3.16	24.78	0.74	12.39	12.68	0.38	6.34	14.68	42.17	0.35	0.30
15	POSHITA	3.00	16.72	2.08	1.33	16.32	0.49	8.16	8.60	0.26	4.30	15.39	32.15	0.48	0.42
	Grand Mean	2.97	15.47	1.55	4.03	17.90	0.54	8.95	8.50	0.26	4.25	12.72	34.92	0.37	0.36
	S.Em(±)	0.14	0.60	0.10	0.29	0.51	0.02	0.26	0.27	0.01	0.14	0.20	0.90	0.01	0.02
	CV (%)	8.29	6.73	11.19	12.64	4.93	4.93	4.94	5.53	5.53	5.53	2.73	4.47	4.96	7.25
	CD	0.41	1.74	0.29	0.85	1.48	0.04	0.74	0.79	0.02	0.39	0.58	2.61	0.03	0.04

Conclusion

On the basis of the present study, it revealed that there is ample scope for selection of the promising lines for further improvement. Considering the mean performances, seven promising lines IC-286632, NMITLI-101, NMITLI-118, RAS-65, CIM-CHETAK, MWS-218 along with check POSHITA with high yield and quality components were found to be superior and may be utilized further in crop improvement programmes.

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