



RESEARCH ARTICLE

Evaluation and identification of stable and high yielding genotypes for varietal development in amaranthus (*Amaranthus hypochondriacus* L.) under dryland conditions of Malwa region of Madhya Pradesh

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Abstract

The present investigation was carried out during kharif and rabi seasons of the year 2018–19 and 2019–20 under State Plan Project, Dryland Agriculture Research Project, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya (RVSKVV), Gwalior and College of Agriculture, Indore under dryland condition to evaluate the mean performance of the amaranthus accessions under different seasonal conditions, providing insights into their adaptability and yield potential for grain production. The present study material consisted of 51 indigenous *Amaranthus* spp. germplasm collections, including 3 released varieties and 20 accessions from the National Bureau of Plant Genetic Resources (NBPGR), New Delhi. Under dryland conditions, farmyard manure (FYM) was applied at a rate of 10 t/ha, along with a basal dose of nitrogen, phosphorous and potassium (NPK) fertilisers (30 kg N, 20 kg P, 10 kg K/ha.). These fertilisers were applied using urea, single superphosphate and muriate of potash respectively, for grain amaranthus in both seasons. Irrigation scheduling was not required in the kharif season, but in the rabi season, irrigation was applied immediately after sowing, with a minimum of 2 irrigations at 15 days intervals thereafter. Observations were recorded on various yields and their related traits. In grain amaranthus, overall, Betul AMA 17-18-121 was among the best-performing genotypes in terms of growth, vigour and yield in both seasons.

Keywords: amaranthus; farmyard manure; genotypes; high yielding; kharif; National Bureau of Plant Genetic Resources

Introduction

Amaranthus hypochondriacus L., a highly nutritious leafy and pseudocereal grain crop, belongs to the family Amaranthaceae and is reported to be a highly cross-pollinated crop. It has gained renewed attention as a promising food crop due to its resistance to heat, drought, diseases and pests. Additionally, its unique C₄ metabolic pathway contributes to its wide adaptability across diverse environmental conditions (1). The Himalayan region is considered the center of diversity for this crop and it is mainly grown for grain production in Uttarakhand. Cultivation of amaranthus has also expanded in parts of Maharashtra, Gujarat and Madhya Pradesh, contributing to nutritional security in these areas. This crop has the potential to increase production with limited inputs and can thrive across a wide range of agro-ecological zones (2). Despite the introduction of various strains through collection and selection programs, there is a lack of comprehensive evaluation studies on yield, attributing traits and qualitative parameters across different seasons (3). In the context of climate change and the growing expansion of arid

areas worldwide, farmers are increasingly seeking crops with nutritional benefits that require minimal inputs. Such crops can be utilised in multiple ways and can grow alongside other crops, helping to enhance productivity in dry areas, where irrigation is limited. Recognising the significance of nutritious crops like amaranthus and the need to promote their cultivation across different regions of the country, an experiment was conducted to evaluate both the quantitative and qualitative traits of various grain amaranthus varieties. The study aimed to assess these traits across multiple seasons to better understand their performance under varying environmental conditions. This research is essential for identifying the most suitable varieties for different agro-ecological zones, thereby contributing to improved crop productivity and nutritional security.

Materials and Methods

The experimental material for this study comprises of 51 indigenous amaranthus genotypes, including 3 released varieties and 20 accessions obtained from the National Bureau of Plant

Genetic Resources (NBPGR), New Delhi. These genotypes were selected to represent a broad spectrum of genetic diversity with respect to origin, adaptability and yield potential, making them suitable for evaluating stability and performance under the dryland conditions of the Malwa region.” During the 2017–18 periods, these accessions and germplasm were collected for grain amaranthus production, specifically in the kharif and rabi seasons. Following this collection, an experiment was conducted under the State Plan Project, Dryland Agriculture Research Project (DARP), Rajmata Vijayaraje Scindia Krishi Vishwavidyalaya (RVSKVV) and College of Agriculture, Indore, Madhya Pradesh during 2018–19 and 2019–20, covering both kharif and rabi seasons. The experimental design used was a randomized complete block design (RCBD) with 3 replications. In each replication, 2 x 2 sq m plots were arranged, with row spacing of 40 cm and plant spacing of 15 cm. Under subtropical climate having temperature range of 21–45 °C and 26–31 °C in summer and winter seasons respectively. The rainfall in the region is mostly inadequate and erratic. Late commencement, early withdrawal of monsoon and occurrence of 2–3 dry spells during the rainy season are the common features. The annual average rainfall is 964 mm farmyard manure (FYM) was applied at a rate of 10 t/ha, along with a basal dose of nitrogen, phosphorous and potassium (NPK) fertilisers (30 kg N, 20 kg P, 10 kg K/ha.). These fertilisers were applied using urea, single superphosphate and muriate of potash respectively, for grain amaranthus in both seasons. Irrigation scheduling was not required in the kharif season, but in the rabi season, irrigation was applied immediately after sowing, with a minimum of 2 irrigations at 15 days intervals thereafter. All good agricultural practices such as sowing, weeding, fertiliser application, irrigation and harvesting were followed to ensure healthy crop growth. Grain amaranthus was harvested approximately 106 days after sowing in both seasons. All quantitative traits were recorded for each genotype during both kharif and rabi seasons over 2 consecutive years (2018–19 and 2019–20). Observations were recorded on days to 50 % flowering, plant height (cm), number of branches per plant, panicle length (cm), days to maturity and grain yield per plant (g). Data from each season and year were subjected to statistical analysis and pooled analysis of variance (ANOVA) was performed after testing the homogeneity of error variances to assess genotype, season and genotype × season interaction effects under dryland conditions and qualitative traits based on visual observations following standard descriptors for grain amaranthus. Traits such as plant growth habit, leaf colour, panicle colour, panicle shape, seed colour and seed shape were recorded at appropriate growth stages during both seasons. Qualitative data were summarised using frequency and percentage distribution to assess phenotypic variation among genotypes were recorded in both seasons across both years and the two years of data were pooled ANOVA revealed significant differences among genotypes, seasons and genotype × season interactions for most of the quantitative traits, suggesting the presence of substantial genetic variability and differential response of genotypes under varying seasonal conditions during 2018–19 and 2019–20 and were analysed.

Results and Discussion

During the kharif season, germination percentages across

genotypes ranged from 82.17–97.33 %, with an overall mean of 93.08 %. The highest germination rate was observed in NBPGR Ah IC-321281 (97.33 %) and the lowest in CO-1 Kerala AMA 17-18-102 (82.17 %). In the rabi season, germination percentages ranged from 81.00–96.67 %, with a mean of 92.26 %. The highest germination in rabi was recorded in NBPGR Ah IC-258250 (96.67 %). The higher germination percentage during kharif season might be due to the prevalence of favourable conditions and genotype interaction with the environment. During the kharif season, the days taken for germination varied from 3.00–6.83 days, with an overall mean of 4.11 days. The fastest germinating genotypes included Seronj AMA 17-18-103, Moorena AMA 17-18-118 and others at 3.00 days, while Renushree Kerala AMA 17-18-101 took the longest at 6.83 days. The vigour index 1 ranged from 545.29–1002.05, with local collection amaranthus 17-18-104 recording the highest at 1002.05 and Nagpur AMA 17-18-129 the lowest at 545.29. The vigor index 2 ranged from 30.73–77.58, with Dewas AMA 17-18-114 having the highest at 77.58 and Hoshangabad AMA 17-18-123 the lowest at 30.73. In the rabi season, days taken for germination ranged from 5.00–9.50 days, with an overall mean of 6.46 days (Table 1). Bhind AMA 17-18-110 and NBPGR Ah IC-333108 recorded the shortest germination time at 5.00 days, while Renushree Kerala AMA 17-18-101 took the longest at 9.50 days. The long time taken for germination in some genotypes might be due to the presence of seed dormancy, while other genotypes with cream-colored seeds are free from this dormancy. The vigour index 1 ranged from 675.63–1030.75, with Betul AMA 17-18-121 achieving the highest at 1030.75 and Chindwara AMA 17-18-124 the lowest at 675.63. The vigor index 2 ranged from 33.26–83.74, with local collection amaranthus 17-18-104 recording the highest at 83.74 and Hoshangabad AMA 17-18-123 the lowest at 33.26. The germination percentage is directly correlated with the vigour index as reported earlier in seed quality studies (4). During the kharif and rabi seasons, significant variations were observed in key plant traits across genotypes. In the kharif season, plant height ranged from 10.02–42.96 cm at 30 days after sowing (DAS) and 35.06–111.96 cm at 70 DAS, with Ratlam AMA 17-18-115 and Betul AMA 17-18-121 being the tallest. Betul AMA 17-18-121 also exhibited the highest plant weight, leaf length, leaf width and inflorescence length in both seasons. Dewas AMA 17-18-114 had the highest number of branches in both seasons. The earliest flowering occurred in NBPGR Ah IC-321281, while the longest flowering, completion and inflorescence initiation was recorded in Renushree Kerala AMA 17-18-101. The reproductive period ranged from 43.00–56.50 days in kharif and 47.83–62.17 days in rabi. The days to maturity varied from 98.17–122.33 days in kharif and 98.67–123.50 days in rabi. In the kharif season, seed yield ranged from 24.67 g/plot and 0.61 q/ha to 438.18 g/plot and 10.95 q/ha, with Betul AMA 17-18-121 (438.18 g/plot, 10.95 q/ha) recording the highest yield and Hoshangabad AMA 17-18-123 (24.67 g/plot, 0.61 q/ha) the lowest. In the rabi season, seed yield varied from 59.78 g/plot and 1.49 q/ha to 925.94 g/plot and 23.14 q/ha, with Betul AMA 17-18-121 (925.94 g/plot, 23.14 q/ha) yielding the most and Nagpur AMA 17-18-129 (59.78 g/plot, 1.49 q/ha) the least. In the kharif season, test weight ranged from 0.47–0.91 g, with Indore AMA 17-18-131 (0.91 g) showing the highest test weight, while CO-1 Kerala AMA 17-18-102 (0.47 g) recorded the lowest. In the rabi season, test weight varied from 0.52–0.95 g, with Renushree Kerala AMA 17-18-101 (0.95 g) having the

Table 1. Pooled data on growth potential of grain amaranthus in the kharif and rabi season under dryland conditions of Malwa region of Madhya Pradesh

Genotypes	Germination percentage		Days taken for germination		Vigour index 1		Vigour index 2		Plant height 70 DAS (cm)		No. of branches	
	kharif	rabi	kharif	rabi	kharif	rabi	kharif	rabi	kharif	rabi	kharif	rabi
1. Renusree Kerala AMA 17-18-101	88.17	83.00	6.83	9.50	599.18	726.37	39.79	42.33	45.46	63.49	3.37	4.50
2. CO-1 Kerala AMA 17-18-102	82.17	81.00	4.50	8.33	575.56	742.58	43.74	47.04	41.17	70.38	3.80	6.47
3. Seronj AMA 17-18-103	94.50	90.67	3.00	6.00	930.48	974.44	69.53	71.43	82.09	120.72	9.20	10.10
4. Local collection AMA 17-18-104	94.00	94.00	3.83	5.50	1002.05	1003.13	75.04	83.74	76.87	126.64	8.47	11.70
5. Anusree AMA 17-18-105	86.00	84.17	5.33	8.17	570.54	738.45	40.90	43.91	36.50	60.31	3.67	5.44
6. Jabalpur AMA 17-18-106	95.00	92.17	3.83	6.00	873.66	930.36	58.86	67.12	66.87	103.26	6.80	10.80
7. Bhind AMA 17-18-107	94.17	92.17	5.33	5.67	915.03	934.60	56.21	63.00	70.40	96.95	7.44	9.14
8. Shivpuri AMA 17-18-108	91.67	93.17	3.17	6.17	907.48	991.88	62.04	77.08	66.36	158.39	9.23	12.07
9. Morena AMA 17-18-109	90.67	93.17	5.00	6.83	857.48	946.48	60.48	72.48	67.64	112.03	7.60	10.44
10. Bhind AMA 17-18-110	96.67	92.83	3.50	5.00	905.66	970.48	62.57	65.73	75.55	113.42	7.34	9.23
11. Neemuch AMA 17-18-111	94.83	91.67	5.00	6.17	864.61	926.09	55.90	58.91	64.92	104.39	6.04	9.10
12. Mandsaur AMA 17-18-112	91.50	92.33	5.33	6.83	700.40	761.84	41.46	46.72	56.99	87.53	4.34	6.27
13. Neemuch AMA 17-18-113	92.83	94.67	4.33	6.00	922.59	997.95	68.93	70.54	74.95	123.87	9.37	11.40
14. Dewas AMA 17-18-114	92.33	91.50	3.83	5.50	944.37	950.32	77.58	79.89	81.95	122.41	10.94	13.43
15. Ratlam AMA 17-18-115	95.33	92.33	5.00	7.00	933.49	1008.00	64.02	70.86	108.90	135.45	9.34	11.00
16. Gwalior AMA 17-18-116	92.67	93.33	3.83	5.83	672.04	821.00	43.69	49.83	51.25	80.42	4.63	6.94
17. Shivpuri AMA 17-18-117	94.33	91.50	3.67	6.17	863.33	882.50	53.99	57.72	59.50	92.37	6.24	7.53
18. Morena AMA 17-18-118	94.17	93.00	3.00	6.17	827.53	916.32	48.28	61.42	61.58	98.26	5.90	8.44
19. Sehore AMA 17-18-119	91.50	93.17	5.00	6.67	901.47	925.18	54.58	62.52	62.56	108.35	6.60	9.39
20. Sehore AMA 17-18-120	94.17	92.50	4.83	7.00	717.43	812.00	49.80	51.58	52.65	97.42	4.74	6.87
21. Betul AMA 17-18-121	94.50	94.17	4.17	6.67	992.51	1030.75	73.66	75.70	111.96	142.52	9.60	12.90
22. Chindwara AMA 17-18-122	88.67	89.17	6.00	7.50	838.50	855.84	51.26	52.22	66.89	110.55	5.57	7.37
23. Hoshangabad AMA 17-18-123	86.33	83.17	5.83	7.17	547.88	699.34	30.73	33.26	38.01	49.87	2.40	3.47
24. Chindwara AMA 17-18-124	87.17	88.33	4.83	6.67	550.61	675.63	32.34	37.42	42.47	58.49	2.54	4.20
25. Chindwara AMA 17-18-125	91.83	94.17	4.17	6.83	825.13	849.37	45.75	56.10	49.26	72.51	6.00	8.14
26. Chindwara AMA 17-18-126	92.00	90.33	3.83	5.83	926.28	987.37	67.12	68.00	99.82	132.95	7.07	9.90
27. Betul AMA 17-18-127	92.33	92.33	5.17	7.33	916.56	978.61	65.83	74.60	74.02	122.92	8.59	11.14
28. Betul AMA 17-18-128	92.50	92.33	4.33	5.83	910.62	924.04	60.04	64.35	67.74	90.50	7.20	8.72
29. Nagpur AMA 17-18-129	86.67	82.67	5.33	6.83	545.29	681.15	33.09	34.91	41.62	55.28	2.27	3.85
30. Indore AMA 17-18-130	92.33	90.33	4.67	7.83	588.94	735.08	39.49	42.56	35.06	59.40	3.14	4.60

31. Indore AMA17-18-131	96.67	94.33	3.50	6.67	883.58	930.05	53.14	64.16	59.00	78.55	6.47	9.37
32. NBPGR Ah IC-278919	95.00	93.17	3.33	6.17	647.48	775.59	46.56	48.47	40.62	78.87	5.13	6.53
33. NBPGR Ah IC-321281	97.33	94.67	3.00	5.50	651.56	750.99	40.64	41.76	38.62	67.38	4.04	5.90
34. NBPGR Ah EC-223659	95.50	95.83	4.00	6.00	601.52	717.08	34.35	40.57	39.58	72.58	3.73	5.13
35. NBPGR Ah IC-278913	92.83	94.83	3.17	6.83	578.15	792.32	33.63	38.20	39.02	65.84	3.54	6.33
36. NBPGR Ah IC-333108	95.33	95.83	3.17	5.00	622.09	741.38	35.63	45.39	40.66	71.50	3.93	5.54
37. NBPGR Ah IC-322201	95.83	96.33	3.17	6.17	586.59	730.96	32.77	42.70	39.64	63.90	3.57	6.05
38. NBPGR Ah IC-333211	96.33	95.50	4.00	5.17	567.70	711.48	34.19	35.55	36.62	67.85	3.47	4.77
39. NBPGR Ah IC-329550	93.00	93.83	4.00	7.00	555.07	734.42	31.57	33.57	41.07	71.41	3.27	4.24
40. NBPGR Ah IC-313269	95.33	93.00	3.50	6.33	564.44	710.42	33.31	34.33	40.13	64.96	3.60	5.07
41. NBPGR Ah IC-278921	94.83	92.83	3.17	6.67	592.55	753.04	44.18	50.46	42.70	70.82	4.07	5.60
42. NBPGR Ah IC -279966	96.00	95.33	3.67	6.17	566.64	728.37	33.48	35.25	35.36	66.15	3.30	4.40
43. NBPGR Ah IC -329588	94.50	93.17	3.67	5.50	645.15	725.05	36.45	41.09	41.20	70.35	5.04	6.15
44. NBPGR Ah IC-333173	96.67	95.33	3.00	6.83	685.79	893.95	45.13	56.33	43.16	72.56	5.49	7.20
45. NBPGR Ah IC-341551	96.17	95.83	3.67	7.33	631.62	733.52	42.57	43.64	40.41	64.39	4.53	7.00
46. NBPGR Ah IC-278922	93.50	96.17	3.00	6.17	560.44	714.33	31.62	34.78	40.02	87.01	3.63	5.23
47. NBPGR Ah IC-274471	95.83	95.50	4.00	6.17	552.94	712.23	32.60	34.81	35.51	69.86	3.40	4.34
48. NBPGR Ah IC-258250	94.67	96.67	3.83	5.33	590.03	706.92	32.49	36.35	36.48	66.01	3.33	5.20
49. NBPGR Ah IC-279968	93.33	92.33	3.33	6.33	558.05	718.52	39.04	39.77	37.10	66.53	4.17	4.63
50. NBPGR Ah IC-279965	92.50	92.50	3.33	6.17	561.68	727.14	31.00	36.58	35.65	63.97	3.73	4.54
51. NBPGR Ah IC-326896	95.00	92.83	3.67	7.00	554.01	716.83	32.16	34.12	36.13	68.35	3.33	4.27
S.E.m±	0.88	0.97	0.24	0.29	9.77	11.98	0.90	0.97	2.32	2.70	0.26	0.30
C.D. 5 %	2.47	2.72	0.68	0.81	27.41	33.62	2.53	2.72	6.50	7.56	0.72	0.84
C.V. %	1.64	1.82	10.20	7.70	2.34	2.51	3.31	3.23	7.39	5.36	8.31	7.12

highest test weight and CO-1 Kerala amaranthus 17-18-102 (0.52 g) the lowest. In the kharif season, protein content ranged from 12.34–16.40 %, with Neemuch amaranthus 17-18-113 (16.40 %) having the highest, while Chindwara amaranthus 17-18-125 (12.34 %) had the lowest. In the rabi season, protein content varied from 12.18–16.56 %, with Neemuch amaranthus 17-18-113 (16.56 %) again recording the highest and Mandsaur amaranthus 17-18-112 (12.18 %) the lowest (Table 2). The amaranthus genotypes are an excellent source of protein, particularly due to their high content of essential amino acids, especially lysine and methionine. The higher percentage of bran fraction in amaranthus contributes to its elevated protein levels. It is considered a complete protein, as it contains all 9 essential amino acids. The grain yield is a complex quantitative trait considerably influenced by several factors. The grain yield is a complex quantitative trait considerably influenced by several factors. The grain yield increased as the yield-attributing traits such as inflorescence length, number of branches and plant height increased. Plant height, days to maturity, days to flowering and inflorescence length were recognised as key traits directly influencing grain yield. The similar findings with growth parameters were also confirmed by early results for plant height and grain yield (5); for plant height, maturity duration, thousand grain weight and grain yield (6); for grain yield and protein content of grains (7); for germination percentage, time from sowing to harvest, thousand seed weight and protein content of grains (8); for plant height (9); for grain yield (10); for grain yield over the two seasons (11, 12); for grain yield (13); for plant height, stem girth, leaf length and leaf breadth (14); for grain yield and protein content (5); for plant height and grain yield under rainfed condition (16) and for days to 50 % flowering, maturity duration and thousand grain weight (17).

Conclusion

The performance and yield stability of amaranthus genotypes varied across different climatic conditions. Based on the results, genotypes BETUL AMA 17-18-121 exhibited superior grain yield and associated agronomic traits. The genotype BETUL AMA 17-18-121 was identified as more stable, high yielding and well-adapted genotypes under dryland condition of Madhya Pradesh. Thus, this genotype is recommended for cultivation under dryland conditions in Madhya Pradesh.

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Authors' contributions

All authors contributed equally. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

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Table 2. Pooled data on yield and quality potential of grain *amaranthus* in the kharif and rabi season under dryland condition of Malwa region of Madhya Pradesh

Genotypes	Inflorescence length (cm)		Days taken for initiation of inflorescence		Maturity duration (days)		Grain yield (q/ha)		Test weight (g)		Protein content (%)	
	kharif	rabi	kharif	rabi	kharif	rabi	kharif	rabi	kharif	rabi	kharif	rabi
1. Renusree Kerala AMA 17-18-101	6.84	13.26	60.50	57.33	122.33	123.50	0.99	2.89	0.88	0.95	12.45	12.47
2. CO-1 Kerala AMA 17-18-102	4.76	8.12	57.33	52.83	118.33	119.67	0.82	2.44	0.47	0.52	13.16	13.21
3. Seronj AMA 17-18-103	27.55	46.78	45.33	40.33	105.67	107.33	7.64	17.56	0.75	0.82	15.63	15.75
4. Local collection AMA 17-18-104	35.62	47.71	48.33	42.17	105.00	108.33	7.24	18.18	0.70	0.81	13.45	13.25
5. Anusree AMA 17-18-105	5.62	11.74	58.83	55.17	117.17	117.67	0.90	3.43	0.78	0.90	12.77	12.81
6. Jabalpur AMA 17-18-106	21.05	35.11	44.67	40.17	104.67	102.83	4.38	15.75	0.57	0.75	15.77	15.55
7. Bhind AMA 17-18-107	26.91	39.08	45.50	42.33	103.33	104.00	4.81	14.67	0.58	0.76	15.53	15.41
8. Shivpuri AMA 17-18-108	38.89	50.87	52.17	46.83	110.00	109.50	8.08	17.27	0.63	0.76	14.54	14.70
9. Morena AMA 17-18-109	32.03	49.56	46.00	41.67	109.33	110.00	5.05	16.84	0.66	0.72	13.50	13.87
10. Bhind AMA 17-18-110	25.44	39.47	47.83	43.00	108.33	109.00	5.54	17.18	0.57	0.70	15.65	15.41
11. Neemuch AMA 17-18-111	21.66	33.83	50.33	46.67	109.33	109.17	3.81	14.48	0.61	0.79	15.06	15.09
12. Mandsaur AMA 17-18-112	14.30	20.52	44.33	40.50	102.33	104.50	1.75	9.76	0.64	0.68	12.39	12.18
13. Neemuch AMA 17-18-113	34.36	50.13	48.17	43.83	105.00	103.33	6.69	18.52	0.72	0.87	16.40	16.56
14. Dewas AMA 17-18-114	27.92	44.63	51.50	45.33	108.17	109.33	8.98	20.56	0.68	0.83	15.19	15.39
15. Ratlam AMA 17-18-115	35.06	53.79	48.83	43.83	109.67	109.33	9.56	18.81	0.77	0.84	14.33	14.14
16. Gwalior AMA 17-18-116	19.36	28.29	47.17	40.50	100.67	102.83	2.76	11.69	0.58	0.70	13.28	13.14
17. Shivpuri AMA 17-18-117	17.01	27.09	46.00	43.67	109.00	108.50	3.72	12.79	0.73	0.82	13.94	14.01
18. Morena AMA 17-18-118	19.43	37.89	44.83	41.33	109.17	108.00	3.74	12.17	0.68	0.82	14.44	14.31
19. Sehore AMA 17-18-119	23.88	42.82	50.00	47.17	106.67	106.50	4.20	16.14	0.57	0.76	13.60	13.79
20. Sehore AMA 17-18-120	15.04	24.46	46.67	41.83	103.17	103.83	2.21	10.91	0.68	0.81	16.15	16.39
21. Betul AMA 17-18-121	40.68	57.88	50.83	44.33	110.00	109.67	10.95	23.14	0.66	0.78	14.12	14.45
22. Chindwara AMA 17-18-122	23.71	38.53	53.17	48.17	111.00	110.33	3.23	14.58	0.69	0.88	13.49	13.72
23. Hoshangabad AMA 17-18-123	3.47	6.32	57.83	54.50	115.17	115.83	0.61	1.80	0.73	0.86	12.76	12.60
24. Chindwara AMA 17-18-124	4.19	7.48	59.00	53.67	114.00	114.50	0.72	2.12	0.75	0.82	13.54	13.65
25. Chindwara AMA 17-18-125	3.26	5.12	55.83	51.00	115.50	114.50	3.41	12.39	0.84	0.91	12.34	12.36
26. Chindwara AMA 17-18-126	31.49	42.54	51.67	45.83	107.67	107.33	4.34	15.16	0.63	0.78	15.64	15.44
27. Betul AMA 17-18-127	32.48	46.55	47.17	42.67	107.00	107.17	5.36	16.99	0.70	0.78	16.01	16.15
28. Betul AMA 17-18-128	21.32	41.55	52.17	45.17	109.00	108.17	3.93	15.28	0.72	0.84	14.18	14.20
29. Nagpur AMA 17-18-129	4.32	6.83	57.33	51.50	116.50	116.00	0.64	1.49	0.69	0.87	12.44	12.60
30. Indore AMA 17-18-130	4.98	11.51	60.17	56.67	119.67	119.50	0.74	2.83	0.85	0.94	13.50	13.82

31. Indore AMA 17-18-131	4.29	5.66	56.17	52.50	114.50	114.83	3.91	16.45	0.91	0.92	13.16	13.20
32. NBPGR Ah IC-278919	20.56	30.08	43.50	39.17	101.67	102.17	2.65	12.48	0.59	0.79	15.50	15.26
33. NBPGR Ah IC-321281	10.07	26.38	42.17	37.17	99.17	99.17	1.92	10.26	0.55	0.67	13.84	14.02
34. NBPGR Ah EC-223659	15.00	21.00	43.00	40.00	100.00	100.50	2.05	8.97	0.53	0.66	16.18	16.19
35. NBPGR Ah IC-278913	12.42	24.27	42.67	38.33	98.67	100.17	1.85	9.68	0.62	0.74	14.36	14.46
36. NBPGR Ah IC-333108	14.12	24.72	45.50	40.67	103.33	103.17	2.11	10.60	0.62	0.78	15.54	15.83
37. NBPGR Ah IC-322201	16.24	22.01	44.00	41.83	98.17	98.67	1.88	9.85	0.60	0.65	12.81	12.80
38. NBPGR Ah IC-333211	8.74	19.82	47.83	44.33	98.17	100.83	1.37	6.30	0.63	0.72	12.75	12.70
39. NBPGR Ah IC-329550	9.51	19.06	46.00	42.33	98.50	99.83	1.24	7.12	0.59	0.72	15.76	15.74
40. NBPGR Ah IC-313269	12.95	18.24	44.83	39.67	100.50	101.00	1.61	8.74	0.54	0.75	13.65	13.89
41. NBPGR Ah IC-278921	17.17	30.92	46.67	41.50	103.33	102.67	2.55	11.18	0.61	0.71	13.21	13.02
42. NBPGR Ah IC -279966	10.52	17.19	47.83	43.33	104.50	104.50	1.23	6.81	0.60	0.70	14.46	14.55
43. NBPGR Ah IC -329588	13.70	20.34	42.33	38.67	98.50	99.67	2.40	9.38	0.61	0.65	12.65	12.34
44. NBPGR Ah IC-333173	19.09	32.44	47.17	41.67	104.67	105.50	3.01	14.40	0.56	0.73	13.34	13.65
45. NBPGR Ah IC-341551	17.32	22.65	45.00	43.67	105.00	103.83	2.23	11.50	0.53	0.69	14.56	14.77
46. NBPGR Ah IC-278922	10.70	21.35	45.83	41.67	99.17	100.50	1.70	9.29	0.62	0.77	15.43	15.45
47. NBPGR Ah IC-274471	9.93	22.26	43.00	37.67	101.67	101.00	1.21	7.96	0.58	0.66	16.31	16.37
48. NBPGR Ah IC-258250	13.43	19.29	45.33	39.50	100.67	100.33	1.56	8.45	0.57	0.71	13.36	13.51
49. NBPGR Ah IC-279968	14.69	25.48	48.00	44.17	98.50	100.17	2.14	9.43	0.55	0.73	14.99	14.96
50. NBPGR Ah IC-279965	9.37	19.64	42.50	38.17	99.67	99.83	1.32	7.52	0.57	0.68	14.55	14.47
51. NBPGR Ah IC-326896	10.42	17.97	46.33	42.83	102.50	102.83	1.13	6.51	0.62	0.72	13.95	13.85
S.E.m±	1.15	1.49	0.56	0.65	0.55	0.64	0.09	0.12	0.01	0.02	0.14	0.13
C.D. at 5 %	3.22	4.17	1.56	1.83	1.53	1.79	0.23	0.31	0.04	0.04	0.39	0.35
C.V. %	11.37	9.19	1.97	2.56	0.89	1.04	4.38	1.69	3.61	3.41	1.68	1.53

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