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Comparative study of diverse indigenous and exotic barley (*Hordeum vulgare* L.) genotypes for terminal heat tolerance

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Abstract
Barley is one of the most valuable cereal crop and belongs to *Poaceae* family. Among the abiotic stress, heat stress (terminal high temperature) is one of the major causes of lowering productivity of barley crops. Therefore, the present investigation comprising a set of 101 barley genotypes was evaluated at Agriculture Research farm, Banaras Hindu University, during *Rabi* of 2016-17 with aim to finding the terminal heat tolerance with better yielding genotypes. Experiment was conducted at in two date of sowing *viz.,* early sowing was on 22^{nd} November 2016 and late sowing was on 18 December 2016respectively. In early sown condition at the time of grain filling stage, temperature was 20-22 ^{0}C while under late sown condition it was 28-35 ^{o}C. Analysis of variance for 101 genotypes studied in early condition and late condition, it revealed significant differences for all the thirteen and fourteen characters respectively. In the early condition genotype 11^{th} HBSN-175 had highest yield per plant while highest grain per ear recorded on MOROC-9-75 and 1000 grain weight was highest for INBON-05-50. The terminal heat stress varieties as 12^{th} HBSN-7(7.58 g) had highest grain yield per plant and BH-976(49.76) recorded in 1000 grain weightPL-751(29.66) recorded highest for grains per ear. Genotypes having ideal maturity, satisfactory yield under higher temperature could be used under breeding program for crop improvement.

Keywords: Barley, *Poaceae*, genotypes, heat stress

Introduction
Barley (*Hordeum vulgare* L.) is basically a grass crop belongs to grass family Poaceae, tribe triticeae and genus Hordeum which is comprising of nearly 350 species. Out of which Hordeum consists of about 32 species including the wild and cultivated one. The cultivated barley is one of the oldest of the cultivated plants. It is considered to be the fourth most important crop in the world after wheat, maize and rice. The crop resembles white berries and is believed to be excellent for drought-like conditions. It is cultivated in diverse landforms for its tolerance against alkaline soils, frost or drought (Mishra and Shivakumar, 2000) [12]. Barley was mainly cultivated and used for human food supply in the last century but nowadays it is significantly grown for the use of animal feed, malt products and human food respectively. Barley consider as a model crop for plant breeding methodology, genetics, cytogenetics, pathology, virology and biotechnology studies (Hockett and Nilan 1985; Hagberg, 1987) [9, 6]. Barley is a rich source of tocols, including tocopherols and tocotrienols, which are known to reduce serum lethal density level cholesterol through their antioxidant action. Whole barley grain consists of about 65-68% starch, 10-17% protein, 4-9% β-glucan, 2-3% free lipids and 1.5- 2.5% minerals. Hulless or de-hulled barley grain contains 11-20% total dietary fiber, 11-14% insoluble dietary fiber and 3-10% soluble dietary fiber. Due to alternate use of barley in field of brewing industry and medicine, it is considered as highly needed crop of present era. Thus barley has potential to alleviate food shortage and malnutrition as well.

Global warming has become a serious worldwide threat. Heat stress is a serious threat to crop production globally (Hall, 2001, 1992). High temperature is a major environmental factor limiting crop productivity. Prolonged high temperatures cause different morphological, physiological and biochemical changes in crop plants. The ultimate effect is on plant growth as well as development and reduces yield and quality. Breeding for heat stress tolerance can be moderated by breeding plant genotypes which have improved levels of thermo-tolerance using different conventional or advanced breeding tools. Reduced fertility is a common problem associated with heat, and has been found to be caused by high temperatures during meiosis and fertilization in various species, e.g., *Arabidopsis*, tomato, rice, cowpea and barley (Bac-Molenaar *et al.*2015; Giorno *et al.* 2013; Jagadish *et al*. 2014) [2, 5, 10]. The moderately high (30-32 °C) and very high temperatures (>35 °C) during grain filling stage at 10 days after flowering stage it cause the resource availability such as nitrogen and sink-source to grain filling and thus the weight of grain is reduces.

Material and methods

The experiments were conducted during the *Rabi* (winter) season of 2016-17 at the Agriculture Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. The experimental area occupied was quite uniform in respect of topography and fertility. The soil of experimental site is sandy loam having 0.03% carbon approximately. All the 101 genotypes were timely sown on 22nd November 2016 and late sown on 18December 2016 at Agriculture Farm, BHU. Each entry were grown in three replications comprising one row of 2 m length with row spacing of 30 cm and plant placing of 10 cm following Randomized Block Design. The recommended cultural practices were carried out to raise good crop. Temperature data were also recorded at experimental station during cropping season to assess heat shocks or high temperature effects during grain filling stage (terminal heat shocks) and genotype response to these shocks due to late sowing, presented in table: 1

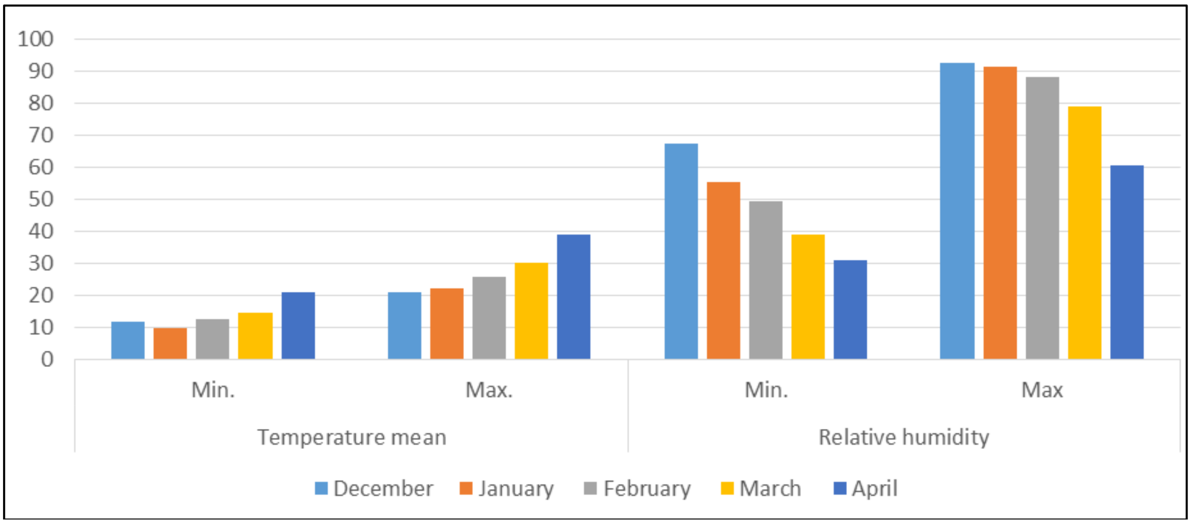

Fig 1: Monthly meteorological data during crop growth period from December 2016 to April 2017

Data on various morphological (Spike length, grains per spike, 1000-grain weight) and phonological traits (days to heading, days to maturity) were recorded to assess the effect of terminal high temperature on these yields and yield contributing traits

Results and Discussion

During cropping season, temperature and relative humidity data were also recorded (Figure. 1). Mean data of temperature of each month showed that late sown crop faced serious heat shocks during its grain filling period. Mean temperature of March and April months remained 30.30 °C and 38.9 °C, which is above the threshold value for barley crops.

Relationship of temperature with yield and yield components among various barley genotypes

Temperature during grain-filling period directly or indirectly affected many develop-mental processes in barley crop. Yield and yield components severely decreased due to high temperature shocks.

Days to 50% flowering

Significant difference was observed for days for 50% flowering of barley genotypes at various planting times (Table 1). Mean days for 50% flowering of barley genotypes was significantly (p<0.05) reduced (71.14 days) at late sowing as compared to early sowing (78.25 days). Non-significant differences were observed between early and normal sowing for days to days for 50% flowering. At early sowing, the genotypes namely 22nd IBYT-7, INBON-07-08-8, IBGP-03-65, 22nd IBYT-9-2, IBGP-03-49 took more days to heading whereas 11th EMBSN-22, 11th EMSN-47-03, flowering earlier days than all other genotypes. Due to delay in barley sowing, days to 50% flowering of genotypes was significantly affected. Under late sowing condition, 5 genotypes such as INBON-07-08-8, INBON-07-08-71, ISBCB-02-13, INBON-05-50 and 22nd IBYT-9-2 shows significantly high days to 50% flowering were as, 11th EMBSN-23, 11th, 25th IBON-54-1 and HORMAL shows less days to 50% flowering, compare to remaining all 101 genotypes. Overall mean reduction of 9% for this trait was recorded due to late sowing (Table 1). Similar result was correlated with Hakim *et al*., 2012, reported 14-19% reduction for the period of days to heading in wheat genotypes due to delay in sowing.

Days to maturity

Maturity period of barley genotypes showed significant reduction of days to maturity in late sown condition (Table.1). The mean days to maturity time of barley genotypes at early sowing was higher (113.29days), whereas it was linearly and significantly (p<0.05) reduced (100.53 days) at late sowing condition. In early condition the genotypes which were recorded highest days to maturity as 25th IBON-46(119.33 days), 24th IBON-40-1 (119.00 days), INBON-07-08-8 (118.667 days), K-551(118 days), HIMANI (118 days), INBON-05-50(118days), RATNA(117.33 days), 22nd IBYT-9-2(117.33days) and 12th HBSN-7(117.33 days) while in 11th EMBSN-23(102.66 days), 11th HBSN-1(102.66 days), 11th EBSN-37-1(102days), 26th IBYT-49(99.33days), 11th EMBSN-47-03(98days) and 14th HBSN-05-8(97.33days) recorded lowest days to maturity. In late sowing condition, the highest days to maturity were recorded in following genotypes, 22nd IBYT-7-2(110.33 days), 24th IBON-40-1(110.33 days), 24th IBON-45-1 (110.33 days) and 25th

IBON-39-1(109 days). While in 11th EMBSN-47-03(88 days), 26th IBYT-49(88.33 days), 11th EMBSN-23(88.67 days), 11th EMBSN-22(91.33day) and in YARDU (91.33 days) were recorded lowest days to maturity. Overall mean reduction of 12% for this trait was recorded due to late sowing (Table 1). Oraki *et al.* (2016) [15] found that when 6-row and 2-row barley sown in two different condition *i.e.* in early time and in late time sown thus terminal heat stress caused significant reduction in days to maturity. Nahar *et al*. (2010) [13], reported up to 15% reduction in maturity period of wheat genotypes due to the effect of heat stress.

Effective Tillers/ Plant

Barley genotypes showed significant variability in number of tillers per plant (Table 1). Maximum numbers of effective tillersplant^{-1} recorded in 24th INBON-40-1(13.78), INBON-05-50(13.55), YARDU (12.44), 25th IBON-03-6(12.07) and HIMANI (11.78) while minimum in 11th EMBSN-47-03(6.33), JYOTI (6.55) and LAKHAN (6.55) under early condition. Maximum number of effective tillers plant^{-1} recorded in ATHOULPA (8.89), WfBCB-88(8.78), 13th EMBSN-71(8.56), SONU (8.55) and ALFA-93(8.33) while minimum in AZAD (4.22), K-551(4.33), 11th EMBSN-40(4.55) and 24th IBON-1(4.78) recorded under terminal heat stress condition. On an average decline of 33.4% in effective tillers plant^{-1} were caused by the heat stress condition against normal condition. The potential number of tillers varies with genotype, particularly among flowering types, winter types having a greater number. Navnesh *et al.* (2016) also reported that plant population reduced by plants experience high temperature stress. Combined effect of high air temperature (27-33 °C) and water stress (-3 to -0.9 MPa) reduces seed germination, causes unequal seedling emergence, and results in variation in the number of plants/unit area, ultimately decreasing seed yield and quality (Hampson and Simpson, 1990) [8].

Spike length with awn (cm)

The spike length (cm) varied under early and late sown (stress condition). The average spike length was altered by 7.9% in late sown condition as compared to the normal one (Table 1). The mean spike length with awn of early condition was 20.13 cm, while late condition has 18.52 cm. The highest spike with awn for early condition were observered in HIMANI (23.16cm), INBON-05-50 (22.63 cm), CIHO-8355(22.49 cm), HORMAL(22.46 cm) and K-603(22.39), while genotypes 22nd IBYT-99-11(17.43 cm), LAKHAN(17.63cm) and 22nd IBYT-9-2(17.75 cm) recorded lowest spike with awn. The maximum spike length with awn recorded in 22nd IBYT-99-14-1(22.39 cm), K-551(21.72 cm), IBRWAGP-04-66(21.56cm), 25th IBON-39-1(21.50cm), MOROC-9-25(21.31cm), while in 11th HBSN-1(14.39 cm) and 13th EMBSN-46(15.16 cm) observed minimum spike length with awn under late condition. These result corroborated with Pathak *et al.* (2017) [16] who have tested 12 exotic genotypes and one landrace by growing in two dates *i.e.* at one in normal time and another in late time.

Stomatal Conductivity (mmol m^{-1} s^{-1})

The average stomatal conductivity was altered by 66.6% in late sown condition as compared to the normal one (Table 1). In late sowing condition, low SC was recorded while the temperature was more than 30 ^{0}C and high in a normal temperature of about 23 ^{0}C to 25 ^{0}C. Plants with higher SC promote evaporative cooling and thereby reduce thermal stress (Reynolds 2001). The high SC early condition observed in 25th IBON-11(662.93 mmol m^{-1} s^{-1}) followed by 11th EMBSN-37-1(660.90 mmol m^{-1} s^{-1}) and INBON-07-08-71(650.58 mmol m^{-1} s^{-1}). Genotypes showing high SC are due to their inherent capacity for adopting to heat stress through evoporational cooling (Radin *et al.* 1994). The maximum SC recorded for late sown condition in 13th EMBSN-71(266.87 mmol m–2 s–1), followed by 12th HBSN-7(263.80 mmol m^{-1} s^{-1}), 25th IBON-03-11(259.69 mmol m^{-1} s^{-1}) and PL-751 (256.17 mmol m^{-1} s^{-1}).

Proline content

Barley genotypes showed significant variability in flag leaf proline concentration (Table 1). The mean proline conc. (µg g-1) significantly increased under late sown condition (39.54 µg g-1) in comparison to timely sown condition (14.71 µg g-1). Flag leaf proline (µ g g-1) increased by 62.79% due to high temperature stress induced by late sowing; Among the barley genotypes, mean flag leaf proline (micro g g-1) was found to be significantly highest in genotype 7th HMBSN-1-2-1-1 (60.67 µg g-1) over all the genotypes. It was followed by KARAN-16(59.46 µg g-1), 14th HBSN-05-6(55.54 µg g-1) and 11th HBSN-23(54.06 µg g-1) exhibited high values for leaf proline (µg g-1) under late sown condition. In interaction effect of sowing dates and genotypes showed significant differences, genotype INBON-05-50 (27.61 µg g-1) under timely sowing exhibited significantly highest leaf proline (µg g-1) and it was followed by genotypes 11th EMBSN-21 (26.70 µg g-1), HORMAL-25(25.67 µg g-1) and LAKHAN-25(25.42 µg g-1) under timely sowing. Similar findings were reported by several authors, Ahmed and Farooq (2013) [1] revaled that accumulation of proline contents at flag leaf stage differed significantly among varieties for various planting times. The late sowing had accumulated the highest proline content (60.67 µg g-1) which can be related to sharp rise in temperature at flag leaf stage. In this situation, plant accumulated the osmolytes such as proline that may lead towards the increase in proline content.

1000 grain weight

The thousand grain weight also mean reduced by 12% from 40.24 g in normal sown condition to 35.41 g in late sown condition (Table.1). The highest TGW was recorded for INBON-05-50 (58.70 g), 11thEMBSN-23 (57.3 g) and the lowest TGW was recorded for CIHO-5923 (25.53 g), 11th HBSN-127 (26.1 g) and BCB-W-03-92 (26.7) in early condition. In late condition, the highest TGW was recorded for BH-976 (49.77g) and 11th EMBSN-23 (49g), while lowest TGW in 11th EMBSN-127(17.4g) and 25th IBYT-10-3 (20.2g). This reduction can be attributed to the lower rate of grain filling due to suppression of photosynthesis and inhibition of starch synthesis in the endosperm leading to reduced growth and shorter period for the production of grains by brief periods of moderately high (30–32 °C) and very high temperatures (>35 °C) during grain filling stage. This result is supported by the findings of Valeria *et al.* (2008) [20], Behrouz *et al.* (2010) [4], Madić *et al.* (2016) [11].

Grain yield per plant

The grain yield varied among Barley varieties in normal and heat stress condition (Table.1). It depends upon genetic potential and tolerance again stress in plants. Heat stress decreases the yield due to affecting growth and development processes, lowering the yield component potential and affecting the activity of key enzymes that contribute a lot during grain filling and development (Wahid *et al*., 2007) [21]. In genotypes like MOROC-9-75(24.4g), MARRIA (23.4g) and GEETANJALI (20.75g) were recorded maximum grain yield, while in INBON-07-08-8(3.53g) and 11th EMBSN-21(6.23g) recorded minimum grain yield per plant in early condition. In late sown condition highest grain yield per plant for 12th HBSN-7(9.72g) and 13th EMBSN-71(9.16 g), while lowest grain yield per plant for INBON-05-50(1.53g) and IBGP-03-65(1.62g) recorded. The mean altered grain yield per pant by 64.5% in late sown condition as compared to the early sown condition. According to Vahid *et al.* (2011) [19] the crop physiological status of plants was remarkably affected by terminal heat stress which ultimately reduced grain yield. Similar result inferred by Pathak *et al.* (2017) [16] that various grain traits were found to be significantly influenced by terminal heat stress and observered that, grain yield, spike length, grain per spike, grain length is reduced in late sown condition as well as dorsal grain width, ventral grain width and thousand grain weight reduced in stressful environment, but sterility was found to be increased.

Table 1: Evaluation of barley genotypes for various phonological and some quantitative traits at two different planting time

S. No	Genotypes	Days to 50% flowering		Days to maturity		Effective Tillers/ Plant		Spike length with awn(cm)		Stomatal Conductivity (mmol m–2 s–1)		1000 grain weight		Grain yield per plant		Proline Conc. (μmolg^{-1})	
		Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late
1	INBON-05-50	84.33	85.67	118.00	101.00	13.55	5.11	22.63	19.07	613.17	99.80	58.70	31.50	8.12	1.53	27.61	46.70
2	INBON-07-08-8	96.00	88.33	118.67	104.00	10.56	6.45	19.87	16.95	549.18	117.73	45.41	23.63	3.53	2.11	14.46	44.32
3	INBON-07-08-71	87.00	86.00	118.00	103.33	9.22	6.22	21.08	18.44	650.58	126.80	53.19	40.53	11.10	3.10	12.23	45.26
4	INBON-05-79	70.67	65.00	113.33	92.00	11.11	7.67	21.56	16.17	458.62	223.90	32.78	41.47	9.83	6.43	10.92	45.09
5	INBON-05-72	76.67	69.33	112.00	95.00	11.11	5.55	20.21	18.16	451.13	141.93	34.42	39.30	11.73	4.56	10.96	39.61
6	CIHO-3510	78.00	74.00	114.33	103.00	9.28	7.11	19.35	19.00	574.33	233.47	45.97	33.87	18.58	8.64	16.81	45.30
7	CIHO-6260	76.67	78.33	114.00	105.67	8.56	7.33	18.16	18.61	457.03	169.27	34.31	31.16	8.95	7.52	15.81	43.97
8	CIHO-5924	77.00	69.67	118.00	102.00	8.00	7.78	21.22	19.67	531.26	216.27	40.25	47.33	10.69	7.00	12.52	46.57
9	CIHO-5923	76.67	74.00	116.67	100.00	10.22	4.67	18.24	18.45	437.93	177.00	25.53	27.53	7.99	4.36	12.72	46.80
10	CIHO-7603	81.33	75.00	118.00	103.67	10.07	6.45	21.89	17.28	470.10	247.27	42.78	32.11	12.03	7.37	23.46	45.19
11	CIHO-8355	86.67	76.67	115.67	105.33	11.33	6.89	22.49	17.98	366.33	188.93	28.73	28.48	12.40	6.61	8.61	36.07
12	WfBCB-88	75.67	73.67	116.67	99.33	10.89	8.78	21.51	17.78	419.13	196.93	37.72	43.45	8.64	5.60	20.50	38.48
13	WfBCB-91	75.33	75.67	115.67	103.33	9.28	6.33	19.69	18.17	481.97	205.77	39.83	41.27	13.44	6.06	10.41	39.91
14	7th HMBSN-15-2	72.67	66.00	116.33	94.33	9.44	5.78	21.09	19.28	394.00	232.07	33.43	46.37	10.86	7.58	23.45	45.82
15	7th HMBSN-1-2-1-1	70.67	63.00	112.00	90.33	9.22	8.22	18.51	17.83	567.40	148.95	43.83	42.17	9.27	5.97	13.87	60.67
16	IBGP-03-49	90.33	79.67	115.00	103.33	10.22	7.22	19.83	16.00	384.30	101.97	29.69	33.63	7.21	1.83	13.76	43.89
17	IBGP-03-65	94.33	82.00	117.33	107.00	11.33	5.00	18.27	17.61	356.33	96.03	26.90	25.33	13.56	1.62	15.76	41.93
18	IBRWAGP-04-66	76.00	74.00	117.33	103.67	9.40	7.33	21.47	21.56	599.10	243.80	43.34	38.93	10.95	8.23	13.18	48.41
19	IBSCGP-05-16	79.00	76.00	113.00	101.67	10.33	6.78	19.56	18.45	461.03	136.17	35.47	38.74	12.17	3.03	12.65	43.54
20	ISBCB-02-13	85.33	86.00	115.33	102.67	11.11	4.89	20.17	16.17	393.57	143.33	30.80	22.60	12.39	1.88	15.06	47.15
21	ISBCB-02-9	75.33	74.00	112.00	103.67	10.11	6.22	20.80	21.11	566.83	160.37	44.27	33.82	7.34	3.70	13.63	53.67
22	ISBCB-02-10	82.67	78.00	113.67	108.67	10.33	5.44	18.18	19.94	457.33	195.10	33.71	25.63	15.72	4.67	12.87	41.91
23	NBPGR-07-08	76.00	77.33	115.00	106.67	9.22	7.78	21.13	17.67	540.97	237.20	40.33	40.23	11.47	5.35	10.24	44.89
24	BCB-W-03-91	76.00	81.00	113.00	106.00	10.44	5.78	20.06	19.17	590.47	153.57	47.87	33.20	12.85	4.31	10.39	52.57
25	BCB-73	76.00	76.00	107.33	103.33	9.67	7.00	18.00	19.33	493.00	150.30	37.07	33.63	11.43	3.79	12.07	47.72
26	BCB-W-03-92	88.67	83.00	116.67	108.67	10.29	5.22	19.61	18.00	388.83	101.62	26.70	27.53	10.74	3.46	17.21	52.80
27	11th HBSN-127	81.33	73.67	112.33	98.00	9.56	5.22	21.14	19.22	333.97	92.47	26.10	17.40	9.26	1.83	11.18	48.74
28	11th HBSN-175	75.33	74.00	116.00	97.67	11.07	7.22	19.87	17.11	611.53	107.50	42.33	35.20	20.83	3.72	13.61	26.85
29	11th HBSN-91	72.67	61.33	115.67	96.67	8.96	5.34	21.12	17.28	432.63	108.67	34.03	23.40	14.92	2.03	14.13	48.74
30	11th EMBSN-22	62.33	59.00	107.33	91.33	10.39	7.55	20.01	16.56	396.87	154.53	36.33	35.16	8.40	4.73	12.37	46.98
31	11th EMBSN-23	65.00	44.67	102.67	89.67	12.44	8.66	20.40	15.11	641.33	242.43	57.30	49.00	14.89	6.67	20.65	54.06
32	11th EMBSN-26	71.33	61.67	104.00	94.33	10.00	5.22	17.89	17.39	402.67	172.00	33.79	31.67	10.44	3.41	17.89	46.59
33	11th HBSN-1	73.00	61.67	102.67	95.67	10.67	5.56	20.74	14.39	439.13	203.47	36.80	34.73	12.67	5.06	12.33	44.69
34	11th EMBSN-20	71.33	61.00	105.33	92.00	10.22	6.22	19.02	20.00	422.43	108.70	33.36	35.10	11.44	4.13	15.26	42.04
35	11th EMBSN-21	82.00	69.00	113.33	96.67	9.96	6.00	21.23	19.78	466.20	177.00	34.50	33.77	6.23	5.51	26.70	54.09
36	11th EMBSN-34	72.00	61.00	102.00	93.00	9.78	6.78	20.73	17.61	365.83	194.17	35.20	33.53	11.94	6.23	21.29	34.02
37	11th EMBSN-37-1	78.00	80.00	112.33	99.67	11.22	6.22	18.35	17.45	660.90	110.13	55.47	45.53	13.25	2.66	8.83	44.44
38	11th EMBSN-40	82.00	82.00	103.33	99.67	6.50	4.55	20.38	16.61	321.23	111.17	27.70	24.57	7.54	2.91	13.80	40.99
39	11th EMBSN-47-03	62.33	55.00	98.00	88.00	6.33	7.11	20.28	20.39	415.67	117.40	31.93	25.17	7.99	3.96	11.39	36.08
40	11th EMBSN-54	76.66	67.67	116.67	99.67	8.33	7.22	20.56	20.89	563.00	227.20	42.47	34.33	19.78	6.26	11.15	32.65
41	12th HBSN-7	79.00	69.00	117.33	99.67	8.00	8.11	21.28	17.78	541.47	263.80	46.27	38.57	15.95	9.72	11.04	33.96
42	12th EMBSN-2	76.00	78.00	113.33	101.00	8.78	5.33	18.89	19.28	464.83	144.20	35.90	35.30	8.20	4.01	11.20	28.91
43	13th EMBSN-71	76.33	65.00	114.00	104.33	9.78	8.56	19.63	21.00	569.17	266.87	43.33	37.27	21.56	9.16	11.76	36.39
44	13th EMBSN-46	76.33	69.67	109.00	100.00	9.22	6.67	18.50	15.16	576.80	142.83	40.17	34.80	9.34	4.53	12.37	31.37
45	14th HBSN-05-6	84.67	77.67	112.33	107.67	9.33	7.22	18.43	17.83	448.33	178.13	36.12	24.23	8.10	5.26	9.39	55.54
46	14th HBSN-05-8	80.00	73.00	97.33	100.33	10.89	5.44	19.57	17.94	426.63	167.77	35.70	39.63	7.48	4.33	10.31	37.68
47	22nd IBYT-7	97.00	84.33	116.00	103.33	9.39	5.00	17.77	17.56	375.83	111.57	31.53	26.07	9.54	3.79	9.57	41.89
48	22nd IBYT-5-1	77.33	73.67	113.00	105.33	5.96	5.67	20.39	17.28	555.27	141.93	39.30	40.17	9.59	3.13	17.17	46.34
49	22nd IBYT-04-86	75.00	73.00	106.33	108.67	11.61	5.67	19.44	19.16	505.10	176.40	40.62	28.60	11.58	4.54	14.96	37.22
50	22nd IBYT-9-2	91.67	84.67	117.33	104.67	7.61	5.67	17.75	18.39	561.63	111.50	43.62	32.53	9.65	4.28	17.80	43.35
51	22nd IBYT-01-2-2-4	75.00	68.00	109.33	95.33	9.22	6.11	18.56	16.44	389.50	92.70	31.57	26.60	11.50	3.19	17.28	34.37
52	22nd IBYT-7-2	83.67	75.33	116.33	110.33	8.39	7.67	19.61	17.22	421.83	147.34	33.09	33.70	11.64	5.59	23.80	35.04

53	22nd IBYT-99-11	77.00	79.33	117.33	100.67	7.61	6.56	17.44	16.39	453.67	100.50	38.73	26.00	11.82	4.34	10.68	33.61
54	22nd IBYT-04-85	81.33	70.33	114.00	99.33	10.39	8.56	18.78	20.39	520.40	117.42	40.53	30.43	11.68	3.52	10.57	37.22
55	22nd IBYT-99-14-1	83.67	81.67	112.00	102.67	8.39	5.56	18.70	22.39	559.00	106.97	42.82	33.90	11.10	2.11	24.76	20.48
56	24th IBON-40-1	80.00	73.67	119.00	110.33	13.78	8.11	18.13	17.06	583.37	140.00	47.07	37.80	15.98	6.70	23.91	27.49
57	24th IBON-1	84.33	81.00	118.00	110.33	10.00	4.78	20.91	18.42	337.80	160.33	38.60	27.00	12.47	4.01	10.76	48.06
58	25th IBON-45-1	75.00	70.00	112.00	103.33	10.33	5.56	18.40	20.91	386.30	145.32	32.03	31.03	12.82	3.26	10.80	41.43
59	25th IBYT-10-3	85.33	75.00	114.00	105.33	8.33	5.44	19.47	17.00	335.73	103.30	29.63	20.20	6.45	2.02	11.20	27.74
60	25th IBON-54-1	65.33	55.00	105.67	90.33	8.00	7.34	18.22	18.11	563.97	164.70	43.12	42.93	8.65	4.36	9.44	29.78
61	25th IBON-39-1	77.67	66.33	117.00	109.00	9.44	5.55	20.87	21.50	395.43	135.27	39.53	43.67	15.21	3.20	11.20	27.76
62	25th IBON-11	81.33	79.00	114.00	106.33	11.30	7.44	21.28	18.94	662.93	153.60	55.87	47.03	13.21	4.25	11.65	29.79
63	25th IBON-03-11	75.00	64.67	113.33	107.00	9.89	5.89	19.55	17.89	465.57	259.69	44.10	35.30	17.81	7.90	13.02	45.35
64	25th IBON-03-6	65.00	69.00	116.00	107.00	12.08	7.11	20.15	18.33	617.30	155.54	50.97	34.80	12.40	4.28	10.85	24.64
65	25th IBON-46	87.00	79.00	119.33	108.67	8.63	5.56	19.28	20.55	446.03	173.10	43.93	44.97	17.83	6.36	10.35	41.07
66	26th IBYT-16	75.00	74.00	114.00	108.00	10.67	5.67	19.93	17.67	545.53	174.90	36.83	34.67	11.13	4.60	16.89	40.09
67	26th IBYT-11-1	84.00	74.00	116.67	106.33	10.11	6.33	18.28	16.00	404.13	211.60	39.72	45.10	11.58	6.57	10.68	31.50
68	26th IBYT-49	64.00	56.33	99.33	88.33	7.89	5.67	19.85	17.22	365.83	156.10	34.87	31.00	11.51	3.48	18.21	36.69
69	29th IBON-6	76.33	72.67	111.67	102.33	8.33	6.78	21.02	17.39	537.57	174.30	42.50	43.67	12.67	4.61	15.18	38.93
70	AMBER	77.00	68.00	112.67	103.67	10.11	6.33	21.62	19.95	539.07	215.70	44.97	35.13	15.77	5.04	13.96	33.22
71	ALFA-93	81.33	70.33	112.00	99.00	10.11	8.33	21.19	20.05	435.50	106.57	34.97	26.97	17.35	4.03	11.83	43.89
72	SONU	75.00	64.00	113.67	99.00	10.45	8.55	21.78	18.94	478.60	206.33	39.47	36.50	15.82	6.39	13.13	41.00
73	RATNA	79.00	69.00	117.33	97.00	10.88	5.89	20.94	17.33	446.05	164.50	37.80	37.03	18.77	3.60	13.24	45.04
74	ATHOULPA	80.67	76.00	116.67	104.00	8.89	8.89	20.41	18.56	540.93	148.83	43.97	41.50	14.88	5.20	16.13	23.41
75	HORMAL	63.67	53.00	112.33	92.00	8.67	8.00	22.47	16.67	629.83	110.10	54.70	46.07	10.33	2.20	25.67	26.74
76	MARRIA	77.67	69.67	113.33	98.00	9.78	5.78	22.33	20.29	555.20	205.20	45.03	45.47	23.41	6.23	15.69	25.80
77	PL-825	75.00	69.00	112.00	96.00	10.45	5.56	20.67	17.78	550.27	175.25	46.21	44.70	17.49	5.79	22.35	38.04
78	HUB-180	74.33	65.00	115.33	99.00	8.56	5.89	22.11	17.89	625.97	209.07	51.80	35.60	15.12	6.18	12.28	46.17
79	HIMANI	80.67	67.67	118.00	103.67	11.78	5.00	23.16	19.11	402.10	171.67	40.67	38.30	17.07	5.98	11.52	28.61
80	VIJAY	71.33	68.00	116.00	103.33	8.67	7.11	20.89	19.11	439.80	241.30	41.60	40.57	14.59	7.94	22.26	36.67
81	YARDU	75.00	61.67	103.67	91.33	12.44	6.89	21.94	18.33	406.80	177.81	38.77	33.87	11.83	5.34	18.02	27.33
82	PL-751	76.00	70.00	109.33	94.67	8.78	5.89	18.33	17.33	327.55	256.17	28.03	37.50	12.37	8.42	11.83	40.61
83	BH-976	76.33	70.67	117.33	98.00	9.67	6.78	18.33	15.67	576.93	196.93	49.67	49.77	13.06	5.53	10.53	35.04
84	V-MORALES	77.00	73.00	112.67	103.00	9.33	5.22	20.28	18.89	541.73	141.60	48.47	39.23	11.98	3.24	15.15	36.69
85	HANLEY	87.00	81.00	114.33	104.67	10.11	6.89	20.56	17.16	453.30	143.13	42.97	44.60	12.49	3.59	11.91	37.87
86	BEECHER	82.67	81.67	117.33	110.33	9.00	8.00	21.72	18.50	658.56	177.33	50.63	40.67	21.76	4.75	14.37	43.89
87	RD-2715	75.00	69.00	112.00	97.00	7.11	5.89	19.30	15.33	331.90	181.20	32.90	33.67	18.99	5.17	16.48	12.82
88	CANUT	87.00	74.00	117.33	103.33	9.56	5.89	21.33	19.44	545.63	180.50	47.87	35.33	19.83	4.17	15.33	35.93
89	JAGRATI	75.00	74.00	113.67	94.67	11.78	6.33	20.34	16.00	512.93	110.93	42.17	38.50	16.58	2.13	12.26	30.83
90	HUB-113	84.33	56.33	116.67	96.67	7.96	5.33	19.83	17.05	478.47	123.70	41.17	36.40	20.20	2.52	18.74	45.31
91	AZAD	82.00	72.67	115.00	92.67	9.78	4.22	20.41	19.45	481.00	109.90	40.40	33.50	15.82	2.07	15.47	43.72
92	K-551	82.00	68.00	118.00	97.33	9.11	4.33	21.83	21.72	510.40	133.63	40.73	38.60	17.58	2.78	12.72	33.13
93	MOROC-9-75	78.00	70.33	113.33	96.00	7.78	5.89	21.87	21.31	482.63	155.70	40.67	37.80	24.41	3.86	12.18	33.98
94	HARMAL	64.33	64.00	114.67	93.00	9.33	6.00	21.61	15.83	635.00	106.37	52.63	40.45	13.21	2.78	12.67	26.67
95	GEETANJALI	81.33	69.00	116.00	96.67	9.44	7.55	20.33	18.89	527.27	172.10	49.54	37.13	20.75	4.18	19.80	24.92
96	KARAN-16	74.67	76.00	113.67	96.00	7.67	4.89	20.02	16.56	313.97	98.13	28.49	24.92	11.97	2.49	16.24	59.46
97	HUB-113	85.00	53.00	116.00	101.33	8.00	6.45	21.11	21.17	465.77	141.94	41.57	43.63	15.23	4.39	8.80	38.19
98	JYOTI	83.67	69.67	114.00	95.67	6.56	5.89	18.35	16.20	478.30	124.50	44.07	31.97	6.86	2.27	10.93	27.65
99	RD2552	80.67	69.00	115.00	98.33	10.19	7.00	21.76	21.36	500.67	184.03	49.47	35.30	16.83	4.49	15.41	40.17
100	LAKHAN	81.33	65.00	117.00	102.67	6.56	5.22	17.63	15.66	542.27	164.03	50.26	33.77	11.53	3.35	25.42	53.69
101	K-603	80.00	67.67	117.00	99.67	6.78	6.00	22.39	19.89	461.37	156.65	44.60	32.80	11.52	3.68	24.69	43.93
	Mean	78.25	71.14	113.29	100.53	9.58	6.38	20.131	18.52	485.35	161.79	40.24	35.41	12.93	4.58	14.71	39.54

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