Research Article

Ekin
Journal of Crop Breeding and Genetics

7(2):131-138, 2021

www.ekinjournal.com

Ekin International biannual peer-reviewed journal

Stability Analysis of Fodder Cowpea Genotypes under Different Environments

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Citation:
Banık M., Nilanjaya, Sharma VK., 2021. Stability Analysis of Fodder Cowpea Genotypes under Different Environments. Ekin J. 7(2):131-138.

Received: 09.04.2021 ***Accepted: 26.05.2021*** ***Published Online: 29.07.2021*** ***Printed: 30.07.2021***

ABSTRACT

Stability of green fodder yield and its component characters was assessed for thirty genotypes over six environments (two seasons 2019 and 2020 × three environments) to determine the quantitative response of cowpea genotypes. The investigation was undertaken at Pusa Farm of Dr. Rajendra Prasad Agricultural University, Pusa, Samastipur, Bihar under open field and rain-out shelter conditions in randomized block design with three replications. The results green fodder revealed that five genotypes (RL-5, PL-4, EC 97738, FD-2262and FD-2258) were found stable for favourable environment and four genotypes (RL-6, EC 390252, FD-2230, FD-2272) were found suitable for poor environment. The genotype, Kashigauri and Bundel Lobia-1 for green fodder yield were found suitable for average environment and encompasses fair stability and wider adaptation. Therefore, the genotype Kashigauri and Bundel Lobia-1 may be recommended for green fodder production after testing over time and space.

Keywords: Fodder cowpea, rain-out shelter, green fodder yield, stability, regression coefficient

Introduction

Livestock sector of India is one of the largest in the world. In rural areas animals rearing are the backbone of rural farmers and their economy. Deficiency in feed and fodder has been identified as one of the major component in achieving the desired level of livestock production (Kumar et al. 2012). The green fodder production is declining year after year but the projected need of green fodder is increasing. During lean period there animal rearing farmers face fodder shortage which also direct production of better quality feed at cheap cost (Kumari et al. 2017). The animal feeds from straw of wheat, rice, barley, sorghum etc. are encompassing low protein with low energy whereas legume feeds contain high protein which fulfil animal nutrition demand and improves milk production (Praveena et al. 2019).

Cowpea [*Vigna unguiculata* L.Walp] (2n=22) is an important summer/rainy season legume crop. It is one of the most ancient crop and commonly known as Lobia in Hindi, Bora in Bihar and other names *viz*., black eye pea, southern pea, chowla, barbati (Gupta et al. 2017). Cowpea improves soil fertility due to its nitrogen fixing ability and part of major agricultural cropping system (Kyei-Boahen et al. 2017). It is an importance drought tolerant crop and also grow under water stagnation condition as well as summer and rainy season legume crop (Panchta et al. 2021). The cowpea green fodder contains 15-20% crude protein and 50% digestible carbohydrate at the first stage of formation of pod. The fodder-cum-grain cowpea varieties may eradicate nutritional status of farm animals by using cowpea seeds in the preparation of animal ration. Therefore, it is considered as good source of calories, vitamins and minerals and also provides a significant amount of dietary protein and lysine (Ngoc et al. 2019). Besides being used as pulse crop, cowpea's immature pod and green leaf and growing twig can be utilized as vegetable. However, it is more important as the source of green as well as dry fodder. Among fodder legumes, cowpea is grown for both grain and fodder in all tropical and sub-tropical regions (Vu et al. 2017).

Our country is the largest producer of cowpea in Asia, accounts for about 0.5 m t production with 1.5 m ha area and average grain plus fodder yield of 3 q/ha and 25-45 t/ha (Ahmad et al. 2017). The green fodder production is declining year after year but the projected need of green and dry fodder is 16848 and 15042 thousand tonnes (Gupta and Kumar, 2007). In Bihar the prime forage sources is met through less nutritious grasses. Thus, a good fodder source is need of the hour. It is well known fact that the genetic diversity is the primary requirement for a flourishing breeding plan. But, the evaluation of genotypes is a pre-requisite for crop improvement (Arya et al. 2019). After this, the core responsibility of plant breeder is to screen out genotypes; those are suitable genotypes for wider range of adaptation. Genotypes sometimes fail to perform equally in variety of environments as phenotype is the ultimate outcome of interaction between genotype and environment.

The core responsibility of plant breeder is to screen out genotype those are suitable for wider range of adaptation. Genotype sometimes fails to perform equally in variety of environments as phenotype is the ultimate outcome of interaction between genotype and environment. The most widely used method to measure stability was previously proposed (Finlay and Wilkinson, 1963) and later on improved (Eberhart and Russell, 1966). The regression coefficient value (b_i=1) coupled with non-significant (S^2d_i=0) specifies average stability. The stability is denoted as adaptation of varieties to unpredictable and transient environmental conditions. Thus, evaluation of stability in fodder cowpea is important to identify better genotypes to meet the shortage of green fodder to improve health status of animal with higher animal products. This study was undertaken to study stability of plant height, number of branches per plant and green fodder yield in thirty cowpea genotypes.

Materials and Methods

Study site and experimental design

The field experiment was conducted during *Kharif* seasons of 2019 and 2020 at Pusa Farm of Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar. The latitude and longitude of the experiment location are 25.980N and 85.670E, respectively. The mean altitude is 52 m above mean sea level and average annual rainfall of 1234 mm. Weather prevailed during experimental period depicted in Figure 1.

Treatment details

The research was carried out as under open field (two date of sowing 15th July 2019 and 26th July 2019) as well as in rain shelter condition (single date of sowing 15th July 2019) in *kharif* 2019 and in *kharif* 2020 under open field (15th July 2020 and 26th July 2020) as well as in rain shelter condition (15th July 2020) installed at Pusa farm where six different environment conditions named E_1, E_2, E_3, E_4, E_5 and E_6, respectively, were used for stability study. Thirty cowpea genotypes viz., EC 390216, Kashigauri, EC 390268, Kashikanchan, RL-1, RL-2, RL-3, RL-4, RL-5, RL-6, PL-4, EC 97306, EC 390252, IVTC-8, IVTC-10, IVTC-1, EC 97738, EC 9736,PL-2, PL-5, PL-3, FD-2230, FD-2229, FD-2233, FD-2242, FD-2260, FD-2262, FD-2272, FD-2258 and including one check BundelLobia 1 were obtained from different research station of the country was used for the trial. The experiment was laid out in Randomized Block Design with three replications and 45x10 cm spacing.

Observations recorded

The observation was recorded on plant height (cm), number of branches per plant and green fodder yield (g/plant). The plant height (cm) was recorded on five tagged plants in each genotype from each replication at 50% flowering stage. The numbers of branches were also counted from five tagged plants in each replication in all genotype of cowpea at 50% flowering stage. The green fodder yield data were collected by using average of five plants from each plot harvested near ground at 50% flowering stage from 30 genotypes of cowpea. The average data was recorded as g/plant.

Statistical analysis

The stability model of Eberhart and Russell (1966) were followed for analysis of six environment data. It involves the estimation of three stability parameters like mean ($\bar{X}_i$), regression coefficient (b_i) and deviation from regression (S^2d_i), which are defined by the following mathematical model

$Y_{ij} = \boldsymbol{\mu}_i + \beta_i I_j + \delta_{ij}$ (I= 1, 2,……..t and j = 1,2……..S)

Where, Y_{ij}= Mean of ith genotype injth environment

$\boldsymbol{\mu}_i$=Mean of all genotype over all environment

β_i = The regression coefficient of ithgenotype on the environmental index, which measures response of genotype to varying environment

δ_{ij}= The environmental index which is defined as deviation of the mean of all the genotypes at a given environment from the overall mean.

The regression coefficients and the mean value for 30 cowpea genotypes were analysed by INDOSTAT software.

Results and Discussion

Plant height (cm)

The data on mean performance of thirty cowpea genotypes are depicted in Table 1. The plant height data were ranged from 54.66 cm (FD-2229) to 98.89 cm (FD-2258). The early planting date (E_1 and E_4) increases the plant height in all seasons. Likewise, considerable variation in plant height was also reported by Shekara et al. (2012) in fodder cowpea genotypes. For plant height, environment E_4 (75.78cm) was most favourable, followed by E_1 (75.53cm), E_5 (73.51cm), E_2 (71.79cm), E_6 (53.99cm) and E_3 (53.64). The stability parameters ($\bar{x}$, b_i and S^2d_i) as proposed by Eberhart and Russell (1966) of the individual genotypes are illustrated in Table 2. The genotypes *viz*., Kashikanchan, RL-5, EC390252, IVTC-8, PL-5, FD-2242, FD-2260, FD-2258, Bundel Lobia-1 (check) mean were superior to population mean.The examined results shows that only one genotype (FD-2242) was found suitable for average environment ($\bar{x}$>μ, b_i=1, NS S^2d_i) for plant height.Genotypes IVTC-8, PL-5, FD-2260 and FD-2258 were examined as stable in rich environment and three genotypes Kashikanchan, EC 390252, Bundel Lobia-1 (check) were stable in poor environment. El-Shaieny et al. (2015) evaluated cowpea for best planting season and found fall season as most suitable also suggested four cowpea genotypes as stable for total dry seed yield base on three parameter model.

Number of branches/plant

The mean performance of genotypes (Table 2) ranged from 4.40 (IVTC-10) to 8.17 (EC 9736). The early sowing date improves number of branches in both the seasons but under rain-out shelter due to water stress the trait mean reduced significantly. For number of branches/plant, environment E_4 (7.19) was most favourable, followed by E_5 (6.72), E_1 (6.14), E_2 (5.67), E_6 (4.60) and E_3 (4.00). The stability parameters ($\bar{x}$, b_i and S^2d_i) as proposed by Eberhart and Russell (1966) of the individual genotypes are illustrated in Table 2. The genotypes EC 97306 and FD-2272 were found with significant regression coefficient (b_i) value with non-significant S^2di value. Total nine genotypes were found with significant S^2di value. The genotypes RL-6 ($\bar{x}$>μ, b_i=1, NS S^2di) was found as suitable for average environment. The studied results for number of branch also indicated two genotype *viz*., Kashikanchan, IVTC-1, PL-5, PL-3, FD-2260, FD-2258 and Bundel Lobia-1 (check) could consistently do better in favourable environments and the genotypes *viz*., Kashigauri, RL-2, EC 97738 and EC 9736 were found stable in poor environment. Kabir et al. (2009) studied wheat variety and recommended that verity which were sensitive to environmental changes can be incorporate in cultivation for favourable condition. The results of our study is also in parallel with results from cowpea (Singh et al. 2020).

Green fodder yield (g/plant)

The mean performance of thirty cowpea genotypes depicted in Table 3 and it is ranges from 117.38 7(FD-2260) to 217.06 (FD-2258). For green fodder yield/plant (g), environment E_4 (192.30g) was most favourable, followed by E_5 (187.27g), E_1 (185.72g), E_2 (180.00g), E_3 (128.41) and E_6 (123.09). The stability parameters ($\bar{x}$, b_i and S^2d_i) as proposed by Eberhart and Russell (1966) of the individual genotypes are illustrated in Table 4. Genotypes *viz*., Kashikanchan, RL-1, RL-5, RL-6, EC 97306, EC 97738, PL-5 and FD-2262 exhibited significant regression coefficient (b_i) with non-significant deviation from regression (S^2d_i). Total sixteen cowpea genotype were found with ($b_i \leq 1$), twelve genotypes with ($b_i \geq 1$) and two genotypes with (b_i=1). Therefore, based on three parameter model, two genotypes (Kashigauri and Bundel Lobia-1) were found stable for average environment ($\bar{x}$>μ, bi=1, NS S^2di) for this trait. Five genotypes (RL-5, PL-4, EC 97738, FD-2262 and FD-2258) were evaluated as stable for favourable environment and five genotypes (EC 390268, RL-6, EC 390252, FD-2230, FD-2272) were low responsive found suitable for unfavourable environment. El-Shaieny et al. (2015) reported considerable degree of genotypic differences and average stability in cowpea for yield related characters under multiple planting date environments. The deviation for regression if deviated non-significantly from zero (S^2d=0) genotypes were reported as stable for seed yield over all the environments (Manivannan et al. 2019). Similar findings were also obtained by Santos et al. (2015).

Conclusions

Genotypes which have regression coefficient (b_i=1), trait mean more than population mean ($\bar{x}$>μ), small deviation from regression (S^2d_i) are considered as stable which are Kashigauri and Bundel Lobia-1 for green fodder yield and Kashigauri for dry matter % was found suitable for average environment and encompasses fair stability and wide adaptation over different environment. Therefore, the genotype Kashigauri may be recommended for green fodder as well as dry fodder production after testing over time and space.

Table 1. Mean performance of plant height (cm) under six environments and stability parameters.

No.	Genotypes	Plant Height (cm)								
		E_1	E_2	E_3	E_4	E_5	E_6	$\bar{x}$	b_i	s^2d_i
1	EC 390216	63.63	60.56	44.94	70.26	66.43	45.38	**58.53**	0.99	-1.57
2	Kashigauri	70.16	70.23	54.24	72.48	70.86	53.87	**65.31**	0.82*	-7.47
3	EC 390268	71.56	73.15	58.78	72.39	71.19	56.84	**67.32**	0.68*	-5.70
4	Kashikanchan	75.26	76.89	60.85	70.91	73.22	56.11	**68.87**	0.73	4.33
5	RL-1	73.37	64.56	47.43	65.86	71.12	44.24	**61.10**	1.12	3.62
6	RL-2	67.21	60.20	46.31	69.54	69.48	45.64	**59.73**	1.02	-1.07
7	RL-3	69.15	64.20	47.57	66.10	64.29	46.88	**59.70**	0.92	-7.04
8	RL-4	67.90	66.50	47.96	64.82	63.62	45.51	**59.39**	0.91	-3.51
9	RL-5	110.73	103.44	70.73	107.64	99.36	81.01	**95.49**	1.45	12.87*
10	RL-6	67.53	68.78	54.09	72.94	69.57	51.23	**64.03**	0.83	-3.69
11	PL-4	71.42	68.02	53.46	74.69	68.66	48.81	**64.18**	0.96	-3.68
12	EC 97306	70.94	66.50	48.96	73.03	67.53	49.10	**62.68**	1.01	-7.47
13	EC 390252	82.97	81.54	62.01	79.79	82.29	60.84	**74.91**	0.97	-3.98
14	IVTC-8	84.53	75.05	54.73	77.97	77.20	57.99	**71.25**	1.11	-1.19
15	IVTC-10	66.52	63.28	44.09	63.76	62.25	42.18	**57.01**	1.01	-6.03
16	IVTC-1	70.00	67.21	46.35	73.58	68.67	50.49	**62.72**	1.06	-5.60
17	EC 97738	72.82	72.12	58.53	71.10	70.27	56.34	**66.86**	0.68*	-6.13
18	EC 9736	67.11	68.04	56.35	70.74	67.58	50.95	**63.46**	0.71	-2.79
19	PL-2	71.61	63.59	51.62	70.88	64.04	50.58	**62.06**	0.83	-2.27
20	PL-5	87.76	81.98	62.34	91.51	85.21	67.00	**79.30**	1.09	-2.94
21	PL-3	69.36	64.36	44.02	70.03	64.83	46.52	**59.85**	1.08	-7.21
22	FD-2230	74.28	67.26	48.21	80.86	66.18	53.11	**64.98**	1.09	14.22*
23	FD-2229	63.75	57.44	44.58	58.88	62.54	40.75	**54.66**	0.88	-1.45
24	FD-2233	76.13	74.63	47.38	72.61	72.08	50.60	**65.57**	1.20	-1.67
25	FD-2242	93.71	92.67	72.28	93.44	91.97	72.31	**86.06**	1.00	-7.32
26	FD-2260	78.25	69.18	49.36	77.31	79.04	51.91	**67.51**	1.25	-0.70
27	FD-2262	74.14	67.88	46.30	76.27	69.60	50.47	**64.11**	1.17	-4.51
28	FD-2272	75.98	68.13	47.55	79.03	80.58	52.20	**67.25**	1.29	7.47
29	FD-2258	105.80	104.78	81.52	109.02	108.86	83.36	**98.89**	1.20	-4.76
30	Bundel Lobia-1 (Check)	72.17	71.51	56.76	75.86	76.64	57.54	**68.42**	0.82	-4.01
Environmental Mean		**75.53**	**71.79**	**53.64**	**75.78**	**73.51**	**53.99**	**67.37**	**1.00**	-
	CD (0.05)	8.41	8.89	6.03	9.24	8.35	8.90	-	-	-

E1=Environment 1 date of sowing 15 July 2019 in irrigated open field condition, E2=Environment 2 date of sowing 26 July 2019 in irrigated open field condition, E3=Environment 3 date of sowing 15 July 2019 in rainout shelter for drought condition, E4=Environment 4 date of sowing 15 July 2020 in irrigated open field condition, E5=Environment 5 date of sowing 26 July 2020 in irrigated open field condition, E6=Environment 6 date of sowing15 July 2020 in rainout shelter for drought condition, $\bar{x}$=Mean value, b_i=Regression coefficient, s^2d_i=Deviation from regression, *=Significant at 5% level, **=Significant at 0.01% level of significance, CD=Critical difference

Table 2. Mean performance number of branches/plant under six environments and stability parameters.

No.	Genotypes	Number of Branches/Plant								
		E_1	E_2	E_3	E_4	E_5	E_6	$\bar{x}$	b_i	s^2d_i
1	EC 390216	5.60	5.07	3.49	6.61	6.13	5.01	**5.32**	0.84	0.00
2	Kashigauri	6.68	6.54	5.16	7.81	6.59	5.89	**6.45**	0.67	-0.03
3	EC 390268	5.99	5.82	4.51	6.85	6.34	4.00	**5.58**	0.85	0.01
4	Kashikanchan	7.56	7.35	5.91	8.80	8.10	5.13	**7.14**	1.05	0.13
5	RL-1	6.19	5.34	3.61	5.44	5.48	3.05	**4.85**	0.82	0.47**
6	RL-2	5.98	6.68	4.44	6.60	6.85	4.10	**5.77**	0.86	0.27
7	RL-3	4.97	4.37	3.00	5.99	5.99	3.60	**4.65**	0.99	-0.10
8	RL-4	5.85	5.26	3.74	7.37	6.63	4.76	**5.60**	1.04	-0.08
9	RL-5	4.33	3.63	2.68	6.35	6.17	4.53	**4.62**	0.99	0.56**
10	RL-6	6.88	6.81	5.34	8.66	8.11	6.22	**7.01**	0.96	-0.04
11	PL-4	5.03	4.68	3.48	7.15	6.89	4.32	**5.26**	1.12	0.15
12	EC 97306	5.85	5.11	3.30	8.03	7.23	4.11	**5.61**	1.45*	-0.03
13	EC 390252	5.62	5.32	3.90	6.89	6.03	5.11	**5.48**	0.77	-0.03
14	IVTC-8	5.79	4.91	3.30	6.93	5.98	4.31	**5.20**	1.04	-0.08
15	IVTC-10	5.68	4.72	3.16	5.15	4.54	3.16	**4.40**	0.70	0.27*
16	IVTC-1	6.06	5.21	3.34	8.88	8.37	5.04	**6.15**	1.63	0.42**
17	EC 97738	8.67	8.45	6.53	7.39	6.98	5.10	**7.19**	0.55	1.45**
18	EC 9736	8.76	8.43	6.79	9.83	8.27	6.95	**8.17**	0.86	0.09
19	PL-2	5.91	5.33	3.72	7.08	6.22	4.39	**5.44**	1.00	-0.13
20	PL-5	6.93	6.35	4.36	8.57	7.35	4.37	**6.32**	1.34	-0.03
21	PL-3	5.89	5.31	3.26	8.19	8.12	4.74	**5.92**	1.52	0.21
22	FD-2230	6.10	5.22	3.28	6.58	7.12	5.13	**5.57**	1.02	0.20
23	FD-2229	6.03	5.16	3.58	4.88	4.93	2.93	**4.59**	0.65	0.63**
24	FD-2233	4.92	4.57	2.84	6.16	5.21	3.83	**4.59**	0.92	-0.09
25	FD-2242	6.53	6.20	4.70	7.04	5.79	4.01	**5.71**	0.79	0.31*
26	FD-2260	6.91	6.44	3.92	6.67	7.60	4.55	**6.02**	1.08	0.26*
27	FD-2262	5.14	4.80	2.84	5.55	5.29	4.44	**4.68**	0.73	0.04
28	FD-2272	6.13	5.38	3.16	7.51	7.59	4.37	**5.69**	1.40*	-0.04
29	FD-2258	6.56	6.36	4.76	8.82	8.35	5.60	**6.74**	1.23	0.07
30	Bundel Lobia-1 (Check)	5.56	5.32	3.90	7.91	7.40	5.23	**5.89**	1.13	0.23*
Environmental Mean		**6.14**	**5.67**	**4.00**	**7.19**	**6.72**	**4.60**	**5.72**	**1.00**	**-**
	CD (0.05)	0.64	0.63	0.63	1.95	1.39	0.59	-	-	-

E1=Environment 1 date of sowing 15 July 2019 in irrigated open field condition, E2=Environment 2 date of sowing 26 July 2019 in irrigated open field condition, E3=Environment 3 date of sowing 15 July 2019 in rainout shelter for drought condition, E4=Environment 4 date of sowing 15 July 2020 in irrigated open field condition, E5=Environment 5 date of sowing 26 July 2020 in irrigated open field condition, E6=Environment 6 date of sowing15 July 2020 in rainout shelter for drought condition, $\bar{x}$=Mean value, b_i=Regression coefficient, s^2d_i=Deviation from regression, *=Significant at 5% level, **=Significant at 0.01% level of significance, CD=Critical difference

Table 3. Mean performance of green fodder yield/plant (g) under six environments and stability parameters.

No.	Genotypes	Green Fodder Yield/Plant (g)								
		E_1	E_2	E_3	E_4	E_5	E_6	$\bar{x}$	b_i	s^2d_i
1	EC 390216	145.49	138.85	102.14	164.39	145.56	106.72	**133.86**	0.74	15.00
2	Kashigauri	195.44	192.07	145.89	212.99	207.30	139.75	**182.24**	0.99	-14.42
3	EC 390268	198.51	195.20	169.64	224.53	227.74	181.88	**199.58**	0.61	154.19**
4	Kashikanchan	184.79	181.80	133.18	182.65	182.63	130.40	**165.91**	0.83*	-24.81
5	RL-1	186.56	178.41	124.55	191.69	187.44	111.47	**163.35**	1.13*	-31.15
6	RL-2	173.30	165.58	119.53	189.71	195.44	111.40	**159.16**	1.10	39.17
7	RL-3	182.69	175.36	119.43	200.39	191.75	114.60	**164.04**	1.18	-16.99
8	RL-4	162.06	156.29	104.94	169.12	149.95	99.16	**140.25**	0.95	-2.56
9	RL-5	208.86	198.56	134.99	207.19	200.32	118.97	**178.15**	1.26*	-7.21
10	RL-6	202.20	198.38	159.87	210.70	203.00	158.58	**188.79**	0.73**	-34.76
11	PL-4	181.92	176.63	122.95	191.82	200.02	126.90	**166.71**	1.04	17.94
12	EC 97306	139.53	131.84	93.36	150.54	143.17	93.98	**125.40**	0.79*	-24.48
13	EC 390252	202.47	191.82	157.31	211.60	201.71	144.71	**184.94**	0.86	-18.56
14	IVTC-8	174.38	165.37	113.40	171.65	153.14	111.31	**148.21**	0.88	35.53
15	IVTC-10	170.95	164.34	114.82	191.77	197.29	105.80	**157.49**	1.19	66.77*
16	IVTC-1	229.19	223.07	138.88	218.66	209.43	121.33	**190.09**	1.46	98.76**
17	EC 97738	234.76	232.05	151.00	238.61	225.06	136.82	**203.05**	1.45*	9.80
18	EC 9736	220.05	217.13	140.41	210.16	202.57	129.38	**186.62**	1.25	76.85*
19	PL-2	186.81	179.46	120.64	172.96	170.59	113.83	**157.38**	0.97	45.72
20	PL-5	146.28	139.92	95.90	149.28	140.46	90.57	**127.07**	0.84*	-31.06
21	PL-3	172.72	165.24	113.13	169.29	180.19	128.10	**154.78**	0.83	38.42
22	FD-2230	186.39	183.22	151.24	201.22	198.79	139.12	**176.66**	0.80	-6.08
23	FD-2229	154.70	148.09	102.33	160.92	177.87	111.44	**142.56**	0.88	78.37*
24	FD-2233	141.20	138.05	92.38	155.81	152.52	89.15	**128.18**	0.94	-20.64
25	FD-2242	64.50	54.57	68.82	67.64	53.05	128.28	**180.14**	1.09	109.43**
26	FD-2260	72.96	59.89	74.55	72.37	52.53	76.29	**117.38**	0.84	19.15
27	FD-2262	203.79	195.56	138.67	222.19	219.20	127.02	**184.41**	1.30*	2.97
28	FD-2272	181.97	175.69	126.57	191.06	198.54	132.35	**167.70**	0.95	17.42
29	FD-2258	241.75	238.79	172.47	244.27	236.09	168.97	**217.06**	1.13	-19.08
30	Bundel Lobia-1 (Check)	214.57	211.75	159.66	215.64	210.82	144.38	**192.80**	1.00	-12.89
Environmental Mean		**185.72**	**180.00**	**128.41**	**192.30**	**187.27**	**123.09**	**166.13**	**1.00**	**-**
	CD (0.05)	16.66	19.05	12.90	19.15	19.03	17.74	-	-	-

E1=Environment 1 date of sowing 15 July 2019 in irrigated open field condition, E2=Environment 2 date of sowing 26 July 2019 in irrigated open field condition, E3=Environment 3 date of sowing 15 July 2019 in rainout shelter for drought condition, E4=Environment 4 date of sowing 15 July 2020 in irrigated open field condition, E5=Environment 5 date of sowing 26 July 2020 in irrigated open field condition, E6=Environment 6 date of sowing15 July 2020 in rainout shelter for drought condition, $\bar{x}$=Mean value, b_i=Regression coefficient, s^2d_i=Deviation from regression, *=Significant at 5% level, **=Significant at 0.01% level of significance, CD=Critical difference

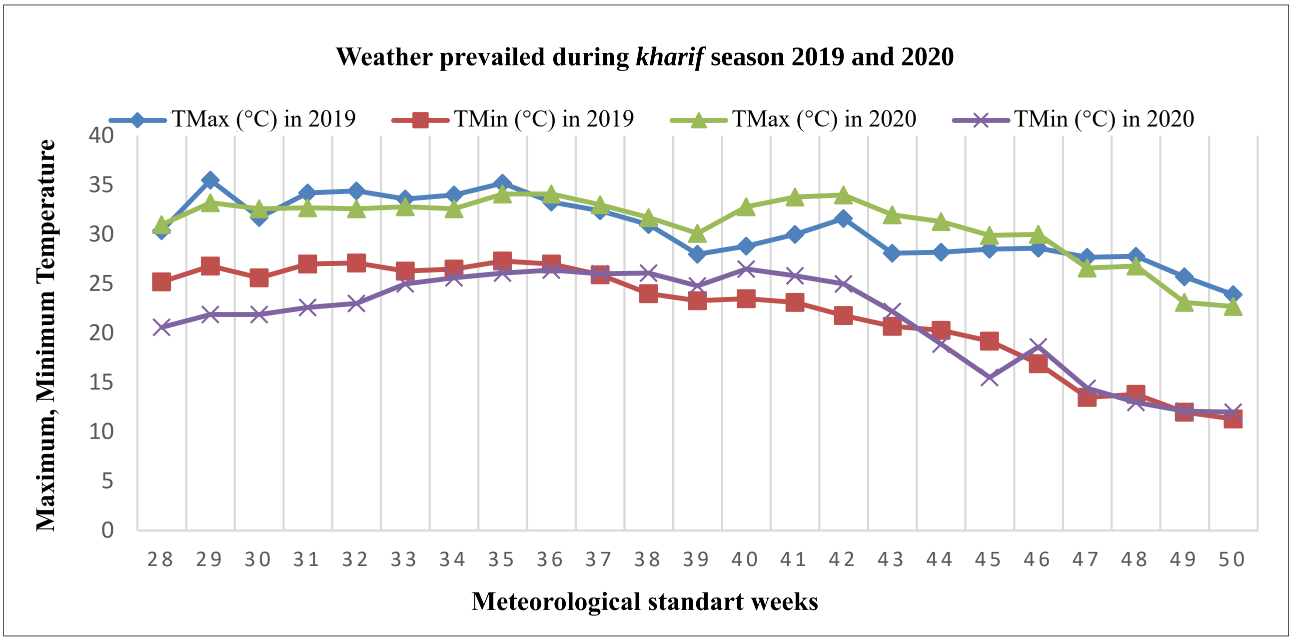

Figure 1.Weather prevailed during experimental period of *kharif* season 2019 and *kharif* 2020.

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