IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 3, Issue 2, March 2021
Impact Factor: 5.731

Estimation of Stability Parameters for Crude Protein Content (%) in Forage Maize (*Zea Mays* L.) Accessions Under Different Environmental Conditions

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Abstract: *Stability analysis for crude protein content (%) using Eberhart and Russel model were worked out in one hundred and one forage maize accessions including African Tall. These accessions were collected from Uttar Pradesh, Madhya Pradesh and Rajasthan through a series of exploration and collection program. Each entry was sown in randomized block design having three replications on well-prepared land with optimum moisture for germination. Observation on various parameters contributing to fodder yield potential were recorded at 50% silking stage of the accessions. Estimation of the crude protein content was done as per the method suggested in A.O.A.C. (1990). In case of crude protein content simultaneous consideration of two-stability parameters, regression coefficient (bi) and sum of square deviation (S2di) suggested the absence of G x E interaction in 54 accessions as the estimates of both these parameters were non- significant in such cases. Maximum crude protein content was observed in IC-334841 (12.24) and IC-334920 (12.12), which was stable in all kind of environments. Highest range of crude protein in forage maize is 11.54- 12.24. Lowest crude protein content (%) was recorded in African Tall (8.66), which was below average in response (bi = 4.56*), therefore, it was stable for unfavourable environments. Among the accessions, three accessions namely IC-334836, IC-334880 and IC-335094 were found unstable.*

Keywords: Forage maize, stability analysis, G x E interaction, crude protein content (%)

I. INTRODUCTION

Maize is grown over a wide range of environments and geographical areas than any other cereal crop, with its multifold use for human, livestock feeding and industry. The residual stover after removal of cobs is important roughage for ruminants in tropical countries. Nutritionally, maize stover has higher crude protein and lower cell wall content and silica than sorghum and pearl millet stover (Sen and Roy, 1971). Cell wall constituents of a plant are very important factor, which affect the forage intake and digestibility (Von Soest, 1965). Sugar contents, leaf–stem ratio and their proportionate thickness have a significant effect on forage yield and its nutritional quality.

Crude protein content, cell wall constituent's concentration and dry matter degradability are the potential criteria for screening the diverse genetic material at initial stage of forage breeding programme from the livestock feeding point of view. The main objective of any forage production programme is to provide nutritious fodder in accordance with the feed requirement of animal (Hulton, 1975).

II. MATERIAL AND METHODS

The present investigation embodied experiment in three environments to study the various growth, yield and quality parameters in forage maize. During investigation a set of 101 accessions was raised during Kharif (first week of July

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2001, 2002 & 2003) as a rain fed crop on a comparatively better-textured sandy loam soil (Parawa) with average moisture holding capacity. Each entry was sown in randomized block design having three replications on well-prepared land with optimum moisture for germination. Each entry was grown in paired row plot of 4-meter length keeping 0.75-meter distance between the rows and 0.15-meter between the plants within a row. Standard agronomic practices were followed and recommended fertilizer dose were applied during the course of experiment. Observation on various parameters contributing to fodder yield potential were recorded at 50% silking stage of the accessions. Estimation of the crude protein content was done as per the method suggested in A.O.A.C. (1990). For this 1g oven dried and grounded dry fodder sample was taken and the catalyst mixture ($CuSO_4$ and K_2SO_4 in a ratio of 1: 5) was added. Further, digestion was done with 20 ml conc. H_2SO_4 for 2-3 hours till it became transparent. Volume was made up to 100 ml in the volumetric flask by adding distilled water. From this flask 5.0 ml solution was taken and distilled in micro Kjeldahl distillation apparatus with 40% NaOH. Released ammonia was collected in beaker containing 4 % boric acid mixed with indicator (methyl red). The colour of indicator changed from red to blue as released ammonia gas was absorbed by boric acid and ammonium borate was formed. Then ammonium borate was titrated with standard solution of N/100 H_2SO_4. Finally 'N' percentage was calculated as:

01 ml of N/100 H_2SO_4 = 0.00014 g N. Percent nitrogen was converted to percent crude protein content by multiplying the percent N by a factor of 6.25.

Crude protein (%) = (%) N X 6.25

Stability parameters were computed as method suggested by Eberhart and Russell (1966).

III. RESULT AND DISCUSSION

In case of crude protein content simultaneous consideration of two-stability parameters, regression coefficient (bi) and sum of square deviation (S^2di) suggested the absence of G x E interaction in 54 accessions as the estimates of both these parameters were non- significant in such cases. Linear component was present for 42 accessions and African Tall as shown by significant regression coefficient. Only two accessions had both bi and S^2di significant, whereas, only one accession showed presence of non- linear component of stability.

Eighteen accessions had above average mean response, out of which 10 accessions were having mean values greater to population mean. Twenty four accessions showed below average response in which ten accessions were having mean values greater to the population mean and remaining 58 accessions and African Tall were average in response in which 28 accessions had their mean more or equal to the population mean that showed their suitability for favourable, unfavourable and general environments, respectively. Out of all accessions including African Tall, 32 accessions had above average mean, 65 accessions had average mean and five accessions and African Tall had below average mean than the population mean. Maximum crude protein content was observed in IC-334841 (12.24) and IC-334920 (12.12), which was stable in all kind of environments. Highest range of crude protein in forage maize is 11.54- 12.24. Lowest crude protein content (%) was recorded in African Tall (8.66), which was below average in response (bi = 4.56*), therefore, it was stable for unfavourable environments. Among the accessions, three accessions namely IC-334836, IC-334880 and IC-335094 were found unstable.

Estimation of stability parameters for crude protein content

S. No.	Acc. No.	Mean	bi	S ^{2}di	S. No	Acc. No.	Mean	bi	S ^{2}di
1.	IC- 334821	10.58	0.73	-0.10	52.	IC- 335025	11.33	-2.23*	0.08
2.	IC- 334825	11.20	3.44*	-0.10	53.	IC- 335027	10.76	0.91	0.20
3.	IC- 334826	11.42	4.71*	-0.13	54.	IC- 335028	10.45	1.01	-0.11
4.	IC- 334830	11.44	2.04	0.47	55.	IC- 335032	10.96	1.11	-0.10
5.	IC- 334833	11.43	2.31	-0.11	56.	IC- 335035	10.17	0.27	0.01
6.	IC- 334834	9.62	1.72	0.77	57.	IC- 335041	10.15	2.07	0.29
7.	IC- 334836	10.16	-0.35	3.43**	58.	IC- 335043	11.54	-1.57*	0.59

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8.	IC- 334837	10.25	0.36	-0.05	59.	IC- 335045	10.39	-0.90*	-0.13
9.	IC- 334838	10.76	4.99*	0.02	60.	IC- 335048	9.77	1.52	0.86
10.	IC- 334841	12.24	3.17	-0.02	61.	IC- 335050	9.47	3.81*	-0.13
11.	IC- 334842	10.47	5.66*	0.04	62.	IC- 335051	11.64	2.23	0.47
12.	IC- 334846	10.50	6.74*	0.08	63.	IC- 335053	10.42	-2.31*	0.14
13.	IC- 334848	11.60	0.34	-0.13	64.	IC- 335056	10.45	-0.84*	0.30
14.	IC- 334853	11.46	1.03	-0.07	65.	IC- 335060	11.62	-2.72*	0.02
15.	IC- 334855	10.34	-0.56*	-0.11	66.	IC- 335062	11.02	-0.34	-0.10
16.	IC- 334863	10.15	4.29*	0.07	67.	IC- 335068	10.58	-0.67*	-0.12
17	IC- 334864	11.34	-2.32*	-0.04	68.	IC- 335069	10.63	0.12	0.08
18.	IC- 334867	10.43	3.60*	-0.03	69.	IC- 335079	10.49	-4.76*	1.17
19.	IC- 334869	11.11	1.28	0.02	70.	IC- 335082	11.10	4.03*	-0.13
20.	IC- 334871	9.02	-3.96*	0.64	71.	IC- 335086	11.41	0.44	-0.03
21.	IC- 334872	9.73	-4.03*	-0.09	72.	IC- 335089	11.02	-1.48*	-0.13
22.	IC- 334876	10.67	-0.16	-0.11	73.	IC- 335092	10.97	2.36	-0.10
23.	IC- 334877	10.48	2.37	-0.12	74.	IC- 335094	10.16	-2.06*	2.03*
24.	IC- 334879	10.95	2.03	-0.11	75.	IC- 335098	10.11	0.40	0.00
25.	IC- 334880	11.65	6.21*	6.07**	76.	IC- 335103	11.75	2.17	0.00
26.	IC- 334881	10.50	5.03*	0.14	77.	IC- 335109	11.09	0.53	-0.07
27.	IC- 334884	10.90	7.21*	0.13	78.	IC- 335110	10.89	1.61	0.01
28.	IC- 334889	11.77	3.28*	-0.12	79.	IC- 335111	10.17	-1.56*	0.09
29.	IC- 334904	11.97	6.90*	-0.12	80.	IC- 335112	10.48	-0.01	-0.12
30.	IC- 334915	11.25	4.38*	0.17	81.	IC- 335115	9.87	0.43	-0.12
31.	IC- 334920	12.12	1.39	0.02	82.	IC- 335116	11.28	1.79	-0.08
32.	IC- 334929	11.03	2.79*	0.15	83.	IC- 335117	11.21	0.33	-0.11
33.	IC- 334932	11.22	0.41	-0.09	84.	IC- 335120	10.77	-0.01	-0.08
34.	IC- 334942	11.53	2.19	-0.13	85.	IC- 335122	10.37	1.42	-0.10
35.	IC- 334943	10.55	6.20*	-0.08	86.	IC- 335128	10.66	1.28	0.14
36.	IC- 334944	11.43	2.67*	-0.07	87.	IC- 335131	10.91	-3.12*	0.14
37.	IC- 334945	10.19	0.38	-0.12	88.	IC- 335138	10.26	2.60*	0.27
38.	IC- 334947	10.80	-0.71*	-0.13	89.	IC- 335141	10.42	1.53	-0.01
39.	IC- 334949	10.15	-0.62*	0.42	90.	IC- 335144	11.12	-2.95*	1.03
40.	IC- 334954	10.94	-2.31*	0.00	91.	IC- 335148	11.99	-1.48*	0.18
41.	IC- 334955	10.64	0.42	0.08	92.	IC- 335149	10.69	-0.34	-0.10
42.	IC- 334957	10.62	1.15	0.15	93.	IC- 335152	10.60	-0.01	-0.03
43.	IC- 334973	10.33	3.06*	0.20	94.	IC- 335156	10.45	1.37	0.95
44.	IC- 334974	11.02	-0.05	1.26	95.	IC- 335158	10.10	2.48	0.47
45.	IC- 334989	10.75	0.01	0.38	96.	IC- 335164	10.90	1.43	-0.03
46.	IC- 334996	10.55	-0.76*	0.60	97.	IC- 335169	10.87	0.53	0.18
47.	IC- 334999	11.00	0.40	-0.11	98.	IC- 335173	10.26	-0.07	-0.07
48.	IC- 335000	10.62	2.18	0.54	99.	IC- 335178	11.11	1.84	0.18
49.	IC- 335009	10.44	1.87	0.51	100.	IC- 335184	10.00	3.73*	0.53
50.	IC- 335017	10.83	-0.53*	-0.12	101.	African Tall	8.66	-4.56*	0.87
51.	IC- 335024	10.48	-3.03*	-0.13					

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Significant at 5% level

Being a cereal crop, maize is not rich in protein content. However, some accessions like IC-334841 and IC-334920 were identified to be very promising as they contain about 11-12.24% crude protein in leaf and stem parts whereas African Tall had very low crude protein content (%) amongst all accessions. These results supported by the earlier findings of Samanta *et al*. (2003). Srivas and Rastogi (2019) reported that IC-334841 were not stable for leaf blade length, while African Tall had maximum sheath length and were stable for all kinds of environments. Singh and Katiyar (1999) studied fodder yield and nutritional variability in leaf and stem of seven maize genotypes and found crude protein value ranged from 10.32 to 12.92 in leaves and 3.49 to 6.69% in stem fraction, respectively.

ACKNOWLEDGEMENT

The authors are thankful to director and principal investigator of NATP project, Indian Grassland and Fodder Research Institute, Jhansi for providing facilities and encouragement and to Indian Council of Agricultural Research, New Delhi (NATP, Plant Biodiversity) for financial assistance.

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