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Stability analysis and genotype x environment interaction (Unreclaimed and reclaimed) for bioassay parameters in Mulberry (*Morus alba* L.,) under alkali affected soils

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Abstract
The objective of this study was to determine stability and genotype x environment interaction of alkali tolerant mulberry genotypes, and the effect of different alkali soils (unreclaimed and reclaimed with organic/ inorganic amendment) on mulberry silkworm bioassay parameters to understand their adaptation. Five alkali tolerant mulberry genotypes along with three check genotypes (two improved and one ruling local genotypes) were evaluated in an alkali hotspot of south India. Wide range of stability statistics was observed among genotypes for all the stability parameters. Genotypes AR-12, AR-14 and AR-10 showed 'b' values much higher than one, indicating that these genotypes respond best under the reclamation treatments. Regression coefficient of each genotype was highly significant and positively correlated with mean.

Keywords: Genotype x environment interaction, bioassay, stability parameters, *Morus alba*

1. Introduction
Sericulture is a unique domain of agriculture combining both botanical aspects of tree cultivation and zoological aspects of silkworm rearing, having four major components i.e. cultivation of host plants, rearing silkworm, reeling of cocoon and fabric production, from soil to silk and silk to cloth. China and India together contribute 97% of the silk produced in the world. World silk production in the year 2018-19 was 1,59,855 MT of which China share was about 1,20,000 MT (75%) and India share was about 35,468 MT (22.19%). India ranks second among the mulberry silk producing countries of the world next only to China with production 25,344 MT [1]. In India, sericulture is practised by over 1.2 million families, with 9.2 million people engaged in various activities of silk production chain in rural and semi-urban areas. Of these, a sizeable number of workers belong to the economically weaker sections of society, especially women with a participation rate of around 55%. Mulberry silkworm is monophagous insect, solely feed on *Morus* sps, which is cultivated in India to the extent of 2.32 lakh ha [1]. As the mulberry leaf production accounts for more than 60% of the cocoon production cost [2, 3], mulberry cultivation plays important role for the sustainability of sericulture in any country.

For increasing income from unit area from any of the cultures like agriculture/ horticulture/ sericulture, it is either by vertically (increasing production per unit area) or by horizontally (expanding more and more new areas for its cultivation). Expansion by vertically is almost saturated as all combination of breeds/ hybrids were developed and under utilization, further increasing yield from silkworm breed is very much limited. Expansion of area under mulberry host plant (horizontally) is the quicker and easier option for growth of sericulture provided suitable additional land is available as other forms like agriculture and horticulture are gaining the upper hand over sericulture. The only alternative therefore is to explore the new areas (affected with alkali, saline and acidic soil), which are apparently not suited for growing agricultural crops.

Alkali soils are the salt affected soils with pH more than 8.5, electrical conductivity (EC) of saturated extract of less than 4 mmhos/cm^2, and exchangeable sodium percentage (ESP) of more than 15 [4]. In generally, alkali soils are low in nitrogen, medium to high in phosphorous and high in potassium contents for macro-nutrients, whereas in case of micro-nutrients, contents of Zinc, Iron, Magnesium and copper are low and contents of Boron and Molybdenum are high compared to normal fertile soils [5]. These alkali soils could be effectively utilized by reclamation, involves reversing the alkali formation process, i.e., replacing excess exchangeable sodium with calcium supplied either through outside source or mobilising precipitated calcium carbonate present in soil. For this purpose, gypsum (direct sources), pyrites, sulphur, acid (indirect sources) and pressmud, green manure and farmyard manure (organic matters) are used [6, 7], which bring in desirable chemical and physical properties of soils for high productivity.

The environmental effect along with genotype x environment interaction (GEI) makes it difficult to verify and give general recommendations for a particular variety. However, several attempts have been made to specify, estimate and correct GEI [8]. The ideal genotype should be high yielding under different environmental conditions, but as genetic effects are not independent of environmental effects, most genotypes do not perform satisfactorily in all environments [9]. When interaction between genotype and environment occurs, the relative ranking of genotypes for yield often differs when genotypes are compared across a series of environments and/or years. This poses a serious problem for selecting genotypes significantly superior in grain yield [10]. GEI are of major importance, because they provide information about the effect of different environments on cultivar performance and have a key role for assessment of performance stability of the breeding materials [11]. Stable genotypes have the same reactions across the environments.

The stability was defined as adaptation of varieties to unpredictable and transient environmental conditions and the technique has been used to select stable genotypes unaffected by environmental changes [12].

The objectives of this study was to evaluate bioassay parameters like larval weight, ERR, Single cocoon weigh, single shell weight and shell ratio%, their magnitude and stability, find quality differences between the genotypes and parameters, find influence of soil alkali condition and genotype and identify most stable genotypes. This has been the first and only attempt of screening mulberry genotypes in alkali soils after reclamation with inorganic and organic amendments.

2. Materials and Methods

The study was conducted at field unit of Central Sericulture Research and Training Institute, Central Silk Board, Mysuru.

2.1 Soil

Natural alkali soils with pH range of 9.3 - 9.5, EC range of 0.32 to 0.84 mmhos/cm, Exchangeable Sodium Percentage (ESP) of 42 and Sodium Adsorption Ratio of 30 and portion of area was used as unreclaimed alkali soil.

2.2 Reclamation

Alkali soil reclaimated with inorganic amendment i.e. gypsum at 8 MT/ha (with a purity of 70-80% and particle size of > 2mm) along with sulphur at 1 MT/ha was used. Alkali soil reclaimated with organic amendment i.e. pressmud at 50 MT/ha with relatively high soluble calcium (from sugar factory employing sulphitation process), was used. These alkali soil reclaimated with gypsum and pressmud were mixed up to 10 cm depth respectively in experimental plots when soil moisture was optimum. Mixing was done by shallow ploughing with country plough followed by planking before the onset of monsoon. Then flooding with about 5-7 cm standing water kept on the soil surface for at least 15 days was given. In between, puddling was practiced to mix the amendments thoroughly in the soil for effective reclamation. After reclamation with gypsum (inorganic)/ pressmud (organic) amendments, the surface of the soil was allowed to dry completely. Then the land was prepared with proper leveling with little or no slope along the width to facilitate movement of water along the length in a uniform sheet with desired depth of application.

Chemical properties of soil samples were analyzed [13] before reclamation and periodically after reclamation with inorganic/ organic amendments. Average pH of the experimental site decreased in soils reclaimed with inorganic (8.3) and organic amendments (7.9) respectively. Average Electric conductivity (EC) of unreclaimed alkali soils was 0.58 mmhos/cm. In case of soil reclaimed with inorganic and organic amendments, the EC was 0.63 and 0.40 mmhos/cm, respectively. ESP was low in soils reclaimed with inorganic amendments (12%), organic amendments (18.6%) in compare with unreclaimed alkali soil (42%). SAR was minimum in soils reclaimed with inorganic amendments (8%) followed by soils reclaimed with organic amendments (14%) compare to unreclaimed alkaline soils (30%).

2.3 Mulberry varieties

Five mulberry genotypes relatively tolerant under alkali soil i.e. AR-12, AR-14, AR-10, AR-08 and AR-29 and two improved checks i.e. V1, S34 and one local check were used in the experiment. 64 plants were maintained per genotype and replication in the net plot. Each net plot/ replication was surrounded by a row of border plants. Three experiments were maintained separately and each of the experiment was conducted following Randomized Block Design with three replications. The plantation was established in the field during monsoon season by planting six month old saplings with 90cm x 90 cm spacing. All regular intercultural operations were attended as per the recommended package of practices. After an initial period of establishment of one year, the plants were pruned at a stump height of 30 cm from the ground level. After pruning and digging, farmyard manure was applied at 20 MT/ha/year in two split doses and thoroughly mixed with the soil by ploughing. The fertilizer schedule followed was 300:120:120 kg of NPK/ha/year in five split doses of 60:60:60 kg NPK/ha after I and III crop and 60 kg nitrogen/ha after II, IV and V crops.

2.4 Bioassay and reeling parameters studied

The genotypes were evaluated for bioassay parameters like Weight of 10 mature larvae (g), ERR by number, ERR by weight, single cocoon weight (g), single shell weight (g) and shell ratio (%) and reeling parameters like AFL (m), NBFL (m), Denier, Renditta, Raw silk (%) and reelability.

2.5 Statistical analysis

Stability parameters were estimated by the standard method [14]. The different parameters were evaluated separately in three different soil reclamation conditions (unreclaimed, reclaimed with inorganic and organic amendments), which were considered as different environments. Analysis of variance (ANOVA) for bioassay parameters was performed by the method used for two-way analysis. After testing the significance of the interaction the stability parameters were performed through the regression coefficient and deviation from regression [14, 15]. The regression coefficient as calculated in this case is considered to be the stability parameter, which is the regression of the performance of each genotype under different reclamation treatment on the environmental means overall the genotypes and calculated as.

$$\text{Regression Co-efficient } (bi) = \frac{\sum_j Yij\, Ij}{\sum_j I^2 j}$$

Where, Yij= mean of i^{th} genotypes on j^{th} reclamation environment

Ij = the environmental index which can be calculated as:

$$= \frac{\sum_j Yij}{t} - \frac{\sum_i \sum_j Yij}{ts}$$

Where, t = number of mulberry genotypes to be tested and
s = number of reclamation treatment (environment)

3. Results and Discussion

3.1 Bioassay parameters of mulberry genotypes under different treatments: The interaction between different treatments indicated in Table 1 and 2.

3.1.1 Interaction studies on average weight of 10 matured larvae: the average weight of 10 matured larvae under different treatments differ significantly ($P<0.05$), with maximum larval weight in case of soil reclaimed with inorganic amendments (32.66 g) followed by soil reclaimed with organic amendments (32.35 g) with minimum in unreclaimed alkali soil (31.01 g). While studying the genotypic interaction under different treatments, it is noticed that AR-12 (34.06 g) and AR-14 (33.79 g) and V1 (33.42 g) were found to be significantly superior over other test genotypes, S34 (improved check) and Local (normal check). The weight of mature larvae was least in case of the AR-10 (30.43 g) among test genotypes. Further, genotype and reclamation interaction proved superiority of AR-12 and the reclamation over other genotypes and unreclaimed alkali soils. AR-12 under soil reclaimed with organic amendments recorded significantly higher weight of 10 matured larvae of 35.02 g over all the test genotypes, improved check, S34 and normal check, Local in different treatments. Least larval weight was recorded in case of AR-10 (29.16 g) among test genotypes under unreclaimed soils.

3.1.2 Interaction studies on average ERR/10000 larvae (by number): A perusal of the table indicated that the reclamation with both inorganic (8494.86) and organic amendments (8538.96) was superior over unreclaimed alkali soils, though there was no significant difference between both the reclaimed treatments. Genotype interaction confirmed the superiority of the genotype AR-12 (8882.69) by its significant difference in ERR by number over other test genotypes, improved check, S34 and normal check, Local. ERR by number was minimum in AR-10 (8352.11) among test genotypes. While studying the treatment and genotype interaction, it was noticed that AR-12 exhibited significantly higher ERR by number under treatments reclaimed with organic (8961.33) and inorganic (8943.93) amendments compared to other test genotypes and checks under different treatments. ERR by number was least in AR-14 (8014.20) under unreclaimed alkali soil.

3.1.3 Interaction studies on average ERR/10000 larvae (by weight): The data on interaction related to average ERR by weight of mulberry genotypes under different treatments. Interaction between different reclamation treatments shows that there was no significant differences between them, though higher ERR by weight was recorded in soil reclaimed with inorganic amendments (14.78 kg) and it was least in unreclaimed alkali soil (13.73 kg). Interaction between mulberry genotypes revealed that AR-12 was found to be significantly superior with highest ERR by weight (15.84 kg) amongst all test genotypes, improved check, S34 and normal check, Local. ERR by weight was least in AR-08 (13.77 kg) among test genotypes. Treatment and genotype interaction revealed that, AR-12 (16.28 kg) under soil reclaimed with inorganic amendments was found to be significantly superior over other test genotypes and checks under all the treatments followed by the same genotype under soil reclaimed with organic amendments (16.05 kg) with no significant difference between the two treatments. Among test genotypes, lowest ERR by weight was recorded in AR-08 (12.97 kg) under unreclaimed alkali soil. It was also found that the ERR by weight has increased in reclaimed treatments compared to unreclaimed alkali soil with slightly higher values in case of soil reclaimed with inorganic amendments.

3.1.4 Interaction studies on average single cocoon weight: Single cocoon weight was highest in soil reclaimed with organic amendments (1.79 g) and minimum in unreclaimed alkali soil (1.73 g). With reclamation of the soil, single cocoon weight increased significantly and it was statistically significant in soil reclaimed with organic amendments as compared to other two treatments. Genotype, AR-12 (1.85 g) recorded highest single cocoon weight and minimum in AR-08 (1.71 g), while studying the interaction between mulberry genotypes. Genotype AR-12 followed by V1 and AR-14 (1.78 g) was found to be significantly superior over all other test genotypes, improved check, S34 and normal check, Local. However, only AR-12 was found to differ significantly with V1 and AR-14 too. Treatment and genotype interaction indicated that the soil reclamation has increased the single cocoon weight in both test genotypes and checks, with maximum increase in case of soil reclaimed with organic amendments. Among all the test genotypes, highest single cocoon weight was recorded in AR-12 under soil reclaimed with organic amendments (1.88 g) and minimum in AR-08 (1.67 g) under unreclaimed alkali soil. AR-12 under the soil reclaimed with organic amendments was found to be significantly superior over other test genotypes and checks in all the treatments.

3.1.5 Interaction studies on average single shell weight: The interaction between the treatments infers that both the treatments i.e., soil reclaimed with organic and inorganic amendments (0.311 and 0.304 g) found to be significantly superior over unreclaimed alkali soil (0.299 g) with respect to single shell weight, with no significant difference between them. While studying the interaction between mulberry genotypes, single shell weight was highest in genotype AR-12 (0.339 g) and lowest in AR-08 (0.292 g) among test genotypes. Only AR-12 was found to be significantly superior over the other test genotypes, improved check, S34 and normal check, Local. Whereas, the interaction between different treatments and genotypes indicated that, the reclamation has improved the performance of all the genotypes including checks with soil reclaimed with organic amendments showing superior performance. AR-12 under both soil reclaimed with organic and inorganic amendments (0.349 and 0.341 g) exhibited significantly higher single shell weight over the other test genotypes, improved check, S34 and normal check, Local under different treatments with no significant difference within the genotype under the above two treatments. Single shell weight was minimum in case of AR-08 (0.282 g) under unreclaimed alkali soil.

3.1.6 Interaction studies on average shell ratio: Interaction between the treatments indicated that the soil reclaimed with organic amendments (17.40%) has recorded the highest shell ratio percentage and minimum was recorded in unreclaimed alkali soils (17.25%), with no significant difference between them at 5% level of significance. Interaction between mulberry genotypes revealed maximum shell ratio percentage in case of AR-12 (18.25%) and found to be significantly superior over all the test genotypes, improved check, S34 and normal check, Local. Minimum shell ratio percentage was minimum in AR-08 (17.08%) among test genotypes. Whereas, the interaction between different treatments and genotypes indicated that, AR-12 under soil reclaimed with organic amendments (18.59%) exhibited maximum shell ratio percentage, which was found to be statistically significant compared to other test genotypes and checks under different treatments. Shell ratio percentage was minimum in AR-08 (16.95%) under unreclaimed alkali soil.

The bioassay is reported to be more reliable [16, 17, 18], most direct and correct method to test mulberry leaf quality [16, 19] and when sufficient leaves are available, it is always suggested to go for complete bioassay though it is laborious and time consuming. Comparative bioassay studies to evaluate the efficacy of the reclamation effect on silkworm rearing were so far not reported. In the present study, bioassay parameters *viz*., weight of 10 mature larvae, ERR by number and weight, single cocoon weight, single shell weight and shell ratio % were observed in the rearings conducted using leaves of genotypes under reclaimed and unreclaimed soil conditions. Significant varietal differences in all the parameters of bioassay, reflecting the differences in leaf quality of different mulberry genotypes grown in saline soils also found in some of the studies [20]. Improvement in cocoon yield and economic characters of cocoons confirms the better quality of mulberry genotypes under reclaimed conditions [21, 22, 23]. The genotypes x environment interactions are major components of variation, i.e., the relative performances of the genotypes vary from one environment to another [24].

3.2 Stability analysis

The results of the combined analysis of stability for bioassay parameters are given in Table 3. An analysis of variance for stability revealed highly significant differences ($P < 0.01$) for bioassay parameters among genotypes and environment + (G x E). This reveals that not only the amount of variability existed among environments but also the presence of genetic variability among the genotypes. The sum of squares due to treatment and genotype x treatment are partitioned into treatment (linear), genotype x treatment (linear) and pooled deviation (nonlinear) from the regression model. The highly significance ($P<0.01$) of these components showed that both predictable and unpredictable components shared GEI.

The Genotype × treatment (linear) interaction was highly significant (tested against pooled deviation) which demonstrated that genotypes respond differently to variation in environmental conditions and indicating existence of differences among the regression coefficients. The pooled deviations equal to pooled error, showing that the differences in stability were due to deviation from linear regression only. Further, the variation in stability of different genotypes performances was mainly due to genotypes by environment interaction.

Pooled analysis of variance overall environments, indicating the genotype, environment and GEI mean squares were highly significant for yield [25]. Therefore, an understanding of GEI provides valid insights into the selection of new stable genotypes in the diversified environmental conditions prevailing in a region. The mean squares due to G x E (linear) were non-significant, depicting lack of genetic differences among genotypes for linear response to varying environments, while the mean squares due to pooled deviations were significant, reflecting considerable differences among genotypes for non - linear response [26]. Genotypes, environments and GEI variances were significant at $P < 0.01$ [27].

3.3 Stability parameters

Bioassay parameters were studied for stability and indicated in Table 4. For Larval weight, AR-12, AR-10 and LOCAL had ‘b’ values much higher than one (1.55, 1.37 and 1.17 respectively), for ERR/10000 larvae (by number), AR-14 and AR-08 had ‘b’ values much higher than one (2.17 and 1.35 respectively), for ERR/10000 larvae (by weight), AR-10 and AR-08 had ‘b’ values much higher than one (1.24 and 1.17 respectively), for Single cocoon weight, AR-14, AR-10 and AR-08 had ‘b’ values much higher than one (1.52, 1.12 and 1.50 respectively), for Single shell weight, AR-12, AR-14 and AR-08 had ‘b’ values much higher than one (2.44, 1.54 and 1.13 respectively), and for Shell ratio %, AR-12 and AR-29 had ‘b’ values much higher than one (4.70 and 2.52 respectively), indicating that these genotypes respond best under the reclamation treatments.

The variations in regression coefficient (bi) values suggested that the eight genotypes responded differently to the different soil environments. Variability among environments is an important factor and mostly determines the usefulness of b values [28]. Deviation from regression (S^2_d) to be the most appropriate criterion for measuring phenotypic stability in an agronomic sense, because this parameter measures the predictability of genotypic reaction to environment; with high and desirable per se performance of a variety across environments is also a positive point to rate the variety as a better and highly stable genotype [29]. A desirable genotype with stability and above average yield should have a regression line with a positive intercept and slope equal to 1.0 and lower deviation from regression [27, 28, 30, 31, 32, 33].

3.4 Reeling performance

The reeling performance of alkali tolerant mulberry genotypes under soil reclaimed with organic amendments were analysed and results were indicated in Table 5. Genotype AR-12 showed having higher 919.13 AFL (m), 873.00 NBFL (m), Denier 2.21, with lesser renditta (8.99), higher raw silk % of 10.72 and reelability of 92.81, though not significant amongst the genotypes and treatments.

Table 1: Bioassay parameters (average weight of 10 matured larvae, Average ERR/10000 larvae (by number), average ERR/10000 larvae (by weight)) of different mulberry genotypes under different treatments

Genotype	Weight of 10 matured larvae				ERR/10000 larvae (by number)				ERR/10000 larvae (by weight)			
	UR	SRI	SRO	Average	UR	SRI	SRO	Average	UR	SRI	SRO	Average
AR-12	32.509	35.022	34.652	34.061	8742.800	8943.933	8961.333	8882.689	15.183	16.280	16.047	15.837
AR-14	33.301	34.236	33.835	33.791	8014.200	8733.933	8699.533	8482.556	14.427	15.198	15.108	14.911
AR-10	29.161	31.737	30.399	30.432	8116.733	8494.533	8445.067	8352.111	13.282	14.591	14.522	14.132
AR-08	30.094	31.263	30.772	30.710	8097.000	8454.000	8580.733	8377.244	12.973	14.245	14.104	13.774
AR-29	31.827	32.859	33.428	32.705	8227.867	8421.867	8455.800	8368.511	13.687	14.510	14.474	14.224
V1	32.336	34.010	33.924	33.423	8355.933	8571.133	8578.067	8501.711	14.282	15.299	15.333	14.971
S34	31.542	32.953	32.833	32.443	8143.933	8264.467	8397.867	8268.756	13.709	14.847	14.828	14.461
LOCAL	27.311	29.195	28.949	28.485	7902.933	8075.000	8193.267	8057.067	12.286	13.264	13.470	13.007
Average	31.010	32.659	32.349		8200.175	8494.858	8538.958		13.729	14.779	14.736	
C.D. at 5% for:												
Treatment (Reclamation)				0.273				118.643				1.191
Genotype				0.446				193.742				0.195
Treatment x Genotype				0.772				335.582				0.337

Where : UR= Unreclaimed alkali soil, **SRI**= Soil reclaimed with inorganic amendments (Gypsum @ 8 MT/ha. + Sulphur @ 1MT/ha), **SRO**= Soil reclaimed with organic amendments (Pressmud @ 50 MT/ha).

Table 2: Bioassay parameters (Average single cocoon weight, Average single shell weight, average shell ratio) of different mulberry genotypes under different treatments

Genotype	Single cocoon weight				Single shell weight				Shell ratio			
	UR	SRI	SRO	Average	UR	SRI	SRO	Average	UR	SRI	SRO	Average
AR-12	1.822	1.859	1.881	1.854	0.326	0.341	0.349	0.339	17.88	18.30	18.59	18.25
AR-14	1.750	1.757	1.828	1.778	0.304	0.309	0.318	0.310	17.36	17.63	17.47	17.48
AR-10	1.718	1.734	1.778	1.743	0.294	0.296	0.304	0.298	17.13	17.07	17.16	17.12
AR-08	1.665	1.723	1.749	1.712	0.282	0.296	0.298	0.292	16.95	17.24	17.05	17.08
AR-29	1.770	1.761	1.799	1.777	0.300	0.299	0.312	0.304	17.01	16.99	17.38	17.13
V1	1.751	1.802	1.792	1.782	0.309	0.319	0.318	0.316	17.69	17.74	17.76	17.73
S34	1.739	1.738	1.778	1.752	0.299	0.298	0.304	0.301	17.25	17.18	17.15	17.19
LOCAL	1.639	1.655	1.689	1.661	0.274	0.272	0.281	0.276	16.75	16.41	16.66	16.61
Average	1.732	1.754	1.787		0.299	0.304	0.311		17.25	17.32	17.40	
C.D. at 5% for:												
Treatment (Reclamation)				0.012				0.003				0.171
Genotype				0.019				0.005				0.279
Treatment x Genotype				0.033				0.009				0.483

Where: UR= Unreclaimed alkali soil, **SRI**= Soil reclaimed with inorganic amendments (Gypsum @ 8 MT/ha. + Sulphur @ 1MT/ha), **SRO**= Soil reclaimed with organic amendments (Pressmud @ 50 MT/ha).

Table 3: ANOVA for stability of bioassay parameters

Source of variation	df	Mean Sum of Squares					
		Larval weight (g)	ERR/10000 larvae (by number)	ERR/10000 larvae (by weight)	Single cocoon weight	Single shell weight	Shell ratio %
Genotypes	7	11.421	166170.00	2.180	0.010	0.001	0.741
Treatment+(genotype x Treatment*)	16	0.909	44144.700	0.368	0.001	0.000	0.032
Treatment (Linear)	1	12.286	542820.00	5.668	0.012	0.000	0.090
Genotype x Treatment * (Linear)	7	0.193	19715.00	0.023	0.000	0.000	0.036
Pooled Deviation	8	0.113	3186.20	0.007	0.000	0.000	0.021
Pooled Error	42	0.230	40448.60	0.039	0.000	0.000	0.089

***** Treatments are considered as environments

** Significant at 1%

Table 4: Estimates of stability and adaptability parameters of bioassay parameters for eight mulberry genotypes across three different soil environments (unreclaimed, reclaimed with inorganic/ organic amendments)

Sl. No.	Genotype	Larval weight (g)			ERR/10000 larvae (by number)			ERR/10000 larvae (by weight)			Single cocoon weight			Single shell weight			Shell ratio %		
		Mean	RC	DR	Mean	RC	DR	Mean	RC	DR	Mean	RC	DR	Mean	RC	DR	Mean	RC	DR
1	AR-12	34.060	1.55	-0.07	8882.69	0.66	-13402.54	15.840	0.96	0.00	1.850	0.99	0.000	0.340	2.44	0.000	18.250	4.7	-0.030
2	AR-14	33.790	0.52	-0.05	8482.56	2.17	-4822.79	14.910	0.71	-0.01	1.780	1.52	0.000	0.310	1.54	0.000	17.490	0.68	0.000
3	AR-10	30.430	1.37	0.35	8352.11	1.08	-8679.43	14.130	1.24	-0.01	1.740	1.12	0.000	0.300	0.64	0.000	17.120	0.21	-0.030
4	AR-08	30.710	0.65	-0.03	8377.25	1.35	-11184.8	13.780	1.17	-0.01	1.710	1.50	0.000	0.290	1.13	0.000	17.080	0.63	0.010
5	AR-29	32.710	0.79	0.27	8368.51	0.67	-13494.36	14.220	0.78	-0.01	1.780	0.54	0.000	0.300	0.99	0.000	17.120	2.52	-0.010
6	V1	33.420	1.07	-0.05	8501.71	0.68	-13182.45	14.970	1.00	-0.01	1.780	0.64	0.000	0.320	0.58	0.000	17.730	0.46	-0.030
7	S-34	32.440	0.89	-0.06	8268.75	0.63	-7795.31	14.460	1.09	-0.01	1.750	0.77	0.000	0.300	0.32	0.000	17.190	-0.67	-0.030
8	LOCAL	28.490	1.17	-0.07	8057.07	0.76	-9811.66	13.010	1.04	0.02	1.660	0.93	0.000	0.280	0.35	0.000	16.610	-0.56	0.030
	Mean	32.007	1.00		8411.33	1.00		14.415	1.00		1.758	1.00		0.305	1.00		17.323	1.00	
	Standard Error	0.237	0.27		39.910	0.22		0.060	0.10		0.012	0.43		0.003	0.57		0.102	1.36	

Where: RC= Regression Co-efficient (bi) and DR= Deviation from Regression (S^2_d)

Table 5: Reeling performance of alkaline tolerant genotypes under soil reclaimed with organic amendments

Sl. No.	Genotype	AFL (m)	NBFL (m)	Denier	Renditta	Raw silk %	Reelability
1	AR-12	919.13	873.00	2.21	8.99	10.72	92.81
2	AR-14	805.67	752.66	2.11	10.84	8.82	91.82
3	AR-10	791.73	707.83	2.19	9.82	10.30	90.39
4	AR-08	756.13	708.01	2.24	9.96	9.86	94.61
5	AR-29	820.13	762.84	2.18	10.03	9.88	88.18
6	V1	803.50	733.13	2.17	9.86	9.75	93.63
7	S34	835.17	769.86	2.14	10.56	9.21	91.99
8	LOCAL	758.43	697.36	2.17	10.45	10.16	90.60

4. Conclusion
The effect of different alkali soils (unreclaimed and reclaimed with organic/ inorganic amendment) on mulberry silkworm bioassay parameters, genotype x environment interaction and stability parameters of alkali tolerant mulberry genotypes were studied and it was found that AR-12, AR-14 and AR-10 genotypes respond better under the reclamation treatments, and alkali soils reclaimed with organic amendment showed better results compare to soil reclaimed with inorganic amendment and control for all the parameters under study. The study also provided some guidelines to the mulberry breeders who are engaged in developing superior genotypes tolerant to alkali soil using various insect bioassay parameters. A proper planning of multiplication and the adoption of reclamation package as suggested is expected to be effective enough for augmentation of all the characters which influence the rearing performance of silkworm.

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