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Research article

Locational trial performance of *Macrotyloma uniflorum* (Lam.) Verdc. and its phenotypic plasticity in three different locations

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Abstract: Legumes are an important source of plant protein next to cereals. Underutilized legumes have significance in subsistence farming and in being the nutritional source for the economically backward population. Horse gram is one such legume that serves both as food for the underprivileged rural people of developing countries and as feed for animals. Though neglected, the plant can be cultivated for cheap nutritional sources in arid regions as it can withstand hardiness and poor fertility conditions. It is grown in a wide range of climatic adversities. Along with nutritional properties, it has several therapeutic properties which make it a plant of interest. These days' underutilized legumes are paid more attention to meet the rising protein requirements for the ever-increasing population across the world. A large number of statistical models have been developed in plant breeding to understand the genotype x environment interaction among plants. This chapter deals with the effect of environment on four characteristics studied of seven genotypes of *Macrotyloma uniflorum* (Lam.) Verdc. (horsegram). In the present investigation four phenotypic characters *viz.*, (a) plant height, (b) seed yield/plant, (c) number of pods/plant and (d) 100 seeds weight of seven accessions and the influence of environment on them are illustrated by the GEI model of Compstock and Robinson. This study will help to find out the suitable condition for the growth of the plant and cultivate it to meet the future consumption requirements of the increasing population.
Keywords: Underutilized - Subsistence - Hardiness - Adversities - Therapeutic - GEI.

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INTRODUCTION

The world population is growing at an alarming rate. Side by side people are facing a rising market cost of food and agri products. Nowadays more attention is being paid to underutilized legumes to meet the needs of protein demand. After cereals, legumes are recognized as the second most significant group of crops comprising essential components of a balanced human diet (Bhadana *et al.* 2013). *Macrotyloma uniflorum* (Lam.) Verdc. seeds are mainly used as feed for animals. It is used as green manure which improves soil fertility tremendously (Prakash *et al.* 2008). The plants have high nitrogen fixation ability and help in soil conservation (Yadav *et al.* 2004). It is generally considered a protein-rich poor man's crop that grows well under dry conditions (low rainfall) and marginal soil fertility (Kiranmai *et al.* 2016). Protein malnutrition is a common problem in the developing world. Being a rich source of protein, vitamins and minerals it can help fight against malnutrition in India as well where only few legumes contribute to the total pulse production. Therefore, to effectively eradicate protein malnutrition, underutilized legumes like horse gram have a great potential in the nutritional security of rural, tribal and underprivileged people (Durst & Bayasgalanbat 2014). The present study was done to identify promising accessions having high vegetative growth and yield capacity. The genotype x environment interaction *i.e.* GEI among three different locations are exhibited here to show that how the environment influences the phenotypic character of an accession. GEI can be defined as the difference between the phenotypic value and the value expected from the corresponding genotypic and environmental values (Baker 1988). The combined effect of genotypes and environments together playing a role in variations in living organisms is known as GEI

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(Dickerson 1962). Varying number of accessions are experimented by agronomists in a range of environmental conditions to implement the influence of GEI. According to Haldane (1947), GEI is important only if genotypes switch ranks from one environment to another. Cross over and non-crossover. If no one genotype has superiority in all situations, GEI indicates the potential for genetic differentiation of populations under prolonged selection in different environments (Via 1984). GEI occurs during, and has an impact on all stages of a breeding programme and has enormous implications for the allocation of resources (Kang 2020).

MATERIALS AND METHODS

Thirty accessions of *Macrotyloma uniflorum* were procured from the National Bureau of Plant Genetic Resource (NBPGR), New-Delhi (Fig. 1). Initially, all these thirty accessions were grown in the research field of the Crop Research Farm (CRF) under this department. Out of those, fifteen accessions were selected based on yield performances for further Ph.D. research work. In this paper GEI of seven accessions *viz.*, (i) IC 203201, (ii) IC 139506, (iii) IC 267941, (iv) IC 385389, (v) IC 49552, (vi) IC 392329, (vii) IC 24842 based on four agronomical characters *viz*., (a) plant height, (b) seed yield/plant, (c) number of pods/plant and (d) 100 seeds weight are displayed. The plant was grown at

Location I: Gagnabad, Adra, Purulia.

Location II: Crop Research Farm (CRF), Golapbag, Burdwan.

Location III: Kashipur, Purulia.

Locations I, II and III differ in their micro-environments. Location II is lesser water deficit zone than the other two.

The experiment was conducted using Randomised Block Design (RBD) with three replications. The spacing between plant to plant and row to row was 25 cm and 30 cm respectively. The crop was sown in two successive years at the same time in all the three locations. Irrigation facilities were provided as and when required.

Figure 1. *Macrotyloma uniflorum* (Lam.) Verdc.: **A**, Location I; **B**, LocationII; **C**, Location III; **D**, Flowering; **E**, Fruiting; **F**, Seeds.

RESULTS AND DISCUSSIONS

The GEI table reveals ample variations amongst the genotypes within the years as well as within the same location and different locations. All these variations of plant height are due to the effect of the environment over the locations and years. The presence of GEI has been demonstrated in table 1 (Plant height after 90 days), table 3 (Seed yield/plant), table 5 (Number of pods/plant) and Table 7 (100 seeds weight) by Comstock and Robinson model (1952); while the mean performance under G x E interaction for each character in tables 2, 4, 6 & 8.

In both the location I and III the accession IC 392329 had the maximum value of plant height. In location II the accession IC 267941 had the highest plant height. The accession IC 203201 exhibited the minimum value for plant height in both the location I and II (Fig. 2A). The accession IC 267941 was the one with the highest value of plant height and IC 24842 had the lowest value of plant height in year 1 and IC 49552 had the maximum plant height and IC 385389 had the minimum plant height in year 2 among all the three locations

Table 1. Plant height after 90 days (cm) averaged over k=5 for 15 varieties of *Macrotyloma uniflorum* (Lam.) Verdc. [g x l x y x r data, replication totals and g x l x g totals]

REP	Location-1								Location -2								Location-3							
	Year 1				Year 2				Year 1				Year 2				Year 1				Year 2			
	I	II	III	∑	I	II	III	∑	I	II	III	∑	I	II	III	∑	I	II	III	∑	I	II	III	∑
IC 203201	6.00	6.30	7.70	20.00	5.50	5.10	5.30	15.90	19.70	12.20	11.50	43.40	18.00	11.00	15.00	44.00	14.85	13.25	12.60	40.70	12.75	10.05	11.15	33.95
IC 139506	9.56	5.90	8.90	24.36	12.00	9.50	10.00	31.50	15.75	18.60	17.90	52.25	14.70	13.00	17.30	45.00	11.65	10.25	11.40	33.30	12.35	12.25	11.75	36.35
IC 267941	15.20	13.80	14.50	43.50	7.00	6.50	6.80	20.30	26.50	37.20	32.70	96.40	14.40	16.40	15.70	46.50	19.50	20.35	21.80	61.65	12.80	10.25	10.50	33.55
IC 385389	10.00	7.20	10.20	27.40	7.10	5.50	6.00	18.60	12.30	15.60	17.00	44.90	14.70	16.00	13.50	44.20	12.10	13.40	12.60	38.10	10.20	9.80	9.75	29.75
IC 49552	13.40	17.90	15.50	46.80	10.40	10.70	9.70	30.80	18.10	20.30	17.80	56.20	22.50	26.50	23.00	72.00	10.78	13.10	12.65	36.53	15.30	14.48	16.00	45.78
IC 392329	19.60	17.20	16.80	53.60	10.30	7.40	11.60	29.30	20.70	15.80	23.60	60.10	21.50	21.00	16.50	59.00	14.18	18.50	15.20	47.88	16.05	17.20	17.40	50.65
IC 24842	5.50	6.40	5.90	17.80	7.30	6.90	7.40	21.60	12.70	20.00	15.70	48.40	17.90	15.30	10.80	44.00	7.90	8.56	8.75	25.21	13.70	14.35	13.25	41.30
∑	79.26	74.70	79.50	233.46	59.60	51.60	56.80	168.0	125.75	139.70	136.20	401.65	123.7	119.20	111.80	354.70	90.96	97.41	95.0	283.37	93.15	88.38	89.8	271.33

Table 2. Mean performance under G x E interaction. [Plant height character]

Genotypes	(A): g x l means			(B): g x y means	
	L_I	L_{II}	L_{III}	Y_1	Y_2
IC 203201	5.983	14.567	12.442	11.567	10.428
IC 139506	9.310	16.208	11.608	12.212	12.539
IC 267941	10.642	23.817	15.867	22.400	11.150
IC 385389	7.667	14.858	11.308	12.267	10.289
IC 49552	12.950	21.377	13.727	15.510	16.526
IC 392329	13.825	19.850	16.422	17.959	15.439
IC 24842	6.567	15.400	11.085	10.157	11.878

Locations	(C): l, y and l x y means		
	Y_1	Y_2	Mean
I	11.12	8.0	9.56
II	19.13	16.89	18.01
III	13.49	12.92	13.21
Mean	14.58	12.6	

Genotypes	(D): g and g x l x y means						
	L_I		L_{II}		L_{III}		Mean
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	
IC 203201	6.67	5.30	14.47	14.67	13.57	11.32	11.00
IC 139506	8.12	10.50	17.42	15.00	11.10	12.12	12.38
IC 267941	14.52	6.77	32.13	15.50	20.55	11.18	16.78
IC 385389	9.13	6.20	14.97	14.75	12.70	9.92	11.28
IC 49552	15.60	10.30	18.75	24.00	12.18	15.28	16.02
IC 392329	17.88	9.77	20.03	19.67	15.96	16.88	16.70
IC 24842	5.93	7.20	16.13	14.67	8.40	13.77	11.02

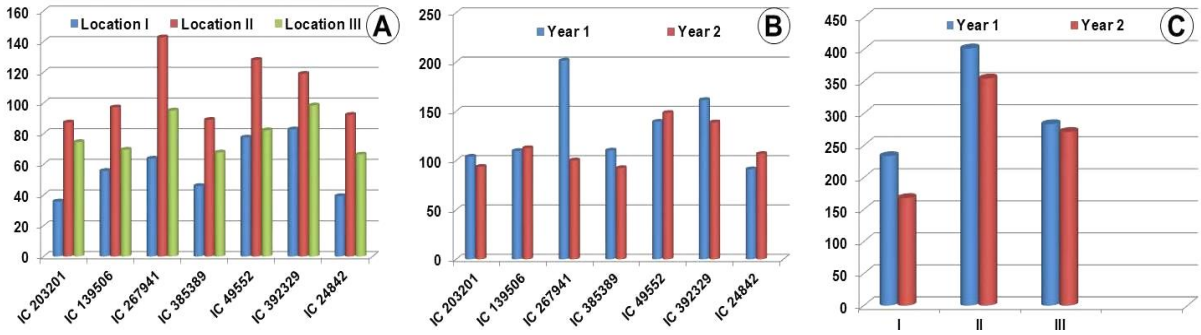

Figure 2. Mean performance under G x E interaction: **A**, g, l and g x l; **B**, y and g x y; **C**, l x y [Plant height character]

studied (Fig. 2B). The phenotypic character plant height after 90 days of the accessions was observed to have the highest values in location II among all the three locations in most of the genotypes in both the years studied (Fig. 2C).

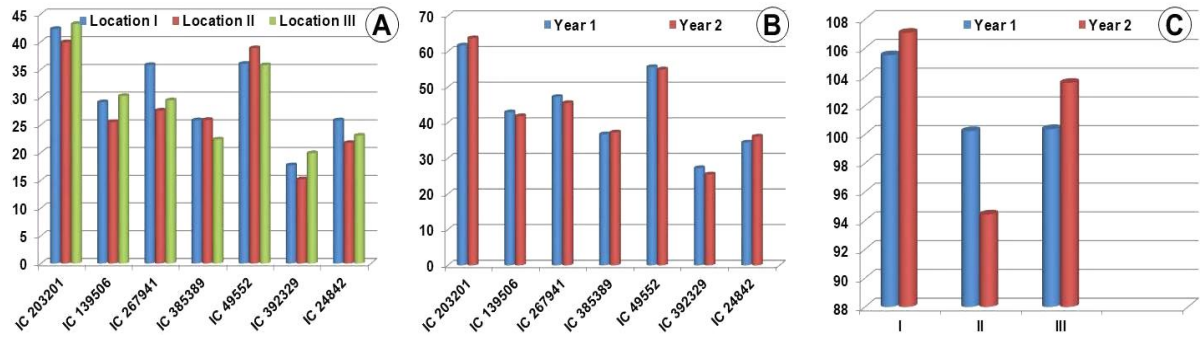

Figure 3. Mean performance under G x E interaction: **A**, g, l and g x l; **B**, y and g x y; **C**, l x y [Seed yield per plant (g)]

IC 203201 had the maximum seed yield in all the three locations. The accession IC 392329 had the minimum amount of seed yield (Fig. 3A). The accession IC 203201 was the highest yielder of seed over all the three locations and in both the years studied (Fig. 3B). The seed yield/plant values were highest in most of the accessions of the crop grown in Location I among all the three locations and for the two years studied (Fig. 3C).

Table 3. Seed yield per plant (g) averaged over k=5 for 15 varieties of *Macrotyloma uniflorum* (Lam.) Verdc. [g x 1 x y x r data, replication totals and g x 1 x g totals]

REP	Location-1								Location -2								Location-3							
	Year 1				Year 2				Year 1				Year 2				Year 1				Year 2			
	I	II	III	∑	I	II	III	∑	I	II	III	∑	I	II	III	∑	I	II	III	∑	I	II	III	∑
IC 203201	6.91	7.33	6.50	20.74	7.15	7.48	6.93	21.56	6.93	7.10	6.68	20.71	6.26	6.37	6.57	19.20	6.83	6.98	6.44	20.25	7.67	7.84	7.46	22.97
IC 139506	5.24	4.97	4.77	14.98	4.81	4.65	4.64	14.10	4.51	4.72	4.12	13.35	4.16	3.91	4.09	12.16	4.71	4.87	5.03	14.61	5.27	4.93	5.40	15.60
IC 267941	5.50	5.87	6.06	17.43	5.99	6.24	6.15	18.38	4.84	4.58	4.99	14.41	4.11	4.56	4.50	13.17	5.16	5.01	5.25	15.42	4.75	4.96	4.30	14.01
IC 385389	4.29	4.11	3.97	12.37	4.49	4.51	4.46	13.46	4.16	4.46	4.36	12.98	4.20	4.23	4.48	12.91	3.68	3.82	3.94	11.44	3.54	3.96	3.43	10.93
IC 49552	5.93	6.12	6.24	18.29	5.77	5.85	6.11	17.73	6.27	6.69	6.73	19.69	6.56	6.25	6.34	19.15	5.90	6.04	5.72	17.66	5.59	6.16	6.35	18.10
IC 392329	3.26	2.92	3.04	9.22	2.80	2.61	3.09	8.50	2.54	2.70	2.86	8.10	2.33	2.17	2.59	7.09	3.14	3.33	3.51	9.98	3.66	3.08	3.18	9.92
IC 24842	4.37	4.17	3.94	12.48	4.42	4.55	4.37	13.34	3.47	3.66	3.86	10.99	3.58	3.71	3.46	10.75	3.67	3.76	3.58	11.01	3.92	4.01	4.13	12.06
∑	35.5	35.49	34.52	105.51	35.43	35.89	35.75	107.07	32.72	33.91	33.6	100.23	31.2	31.2	32.03	94.43	33.09	33.81	33.47	100.37	34.4	34.94	34.25	103.59

Table 4. Mean performance under G x E interaction. [Seed yield/plant (g)]

Genotypes	**(A): g x l means**			**(B): g x y means**	
	L_I	**L_{II}**	**L_{III}**	**Y_1**	**Y_2**
IC 203201	7.050	6.652	7.203	6.856	7.081
IC 139506	4.847	4.252	5.035	4.771	4.651
IC 267941	5.968	4.597	4.905	5.251	5.062
IC 385389	4.305	4.315	3.728	4.088	4.144
IC 49552	6.003	6.473	5.960	6.182	6.109
IC 392329	2.953	2.532	3.317	3.033	2.834
IC 24842	4.303	3.623	3.845	3.831	4.017
Locations	**(C): l, y and l x y means**				
	Y_1			**Y_2**	**Mean**
I	5.02			5.1	5.06
II	4.77			4.5	4.64
III	4.78			4.93	4.86
Mean	4.86			4.84	

Genotypes	**(D): g and g x l x y means**						
	L_I		**L_{II}**		**L_{III}**		**Mean**
	Y_1	**Y_2**	**Y_1**	**Y_2**	**Y_1**	**Y_2**	
IC 203201	6.91	7.19	6.90	6.40	6.75	7.66	6.97
IC 139506	4.99	4.70	4.45	4.05	4.87	5.20	4.71
IC 267941	5.81	6.13	4.80	4.39	5.14	4.67	5.16
IC 385389	4.12	4.49	4.33	4.30	3.81	3.64	4.12
IC 49552	6.10	5.91	6.56	6.38	5.89	6.03	6.15
IC 392329	3.07	2.83	2.70	2.36	3.33	3.31	2.93
IC 24842	4.16	4.45	3.66	3.58	3.67	4.02	3.92

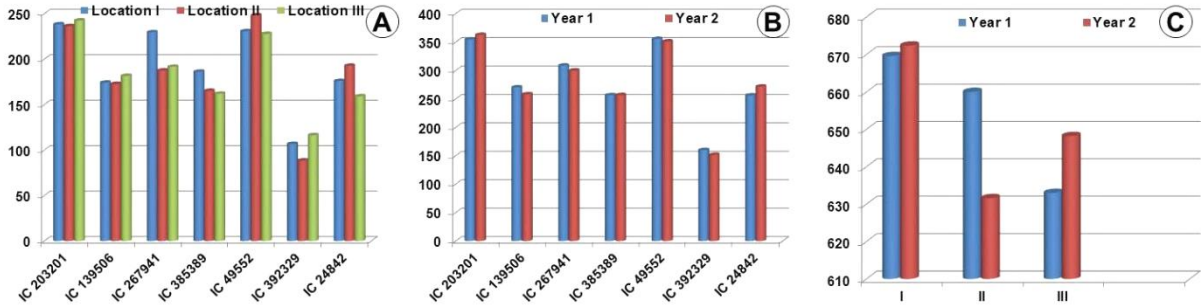

Figure 4. Mean performance under G x E interaction. **A**, g, l and g x l; **B**, y and g x y; **C**, l x y [Number of pods per plant]

In both the location I and III IC203201 and in location III C49552 had the maximum value of no. of pods/plant. The accession IC 392329 had the minimum amount of no. of pods/plant over all the three locations (Fig. 4A). The accession IC 203201 was the highest yielder of number of pods over all the three locations and in both the years studied (Fig. 4B). The number of pods/plant values were highest in the maximum of the accessions of the crop grown in Location I among all the three locations and two years taken into the study (Fig. 4C).

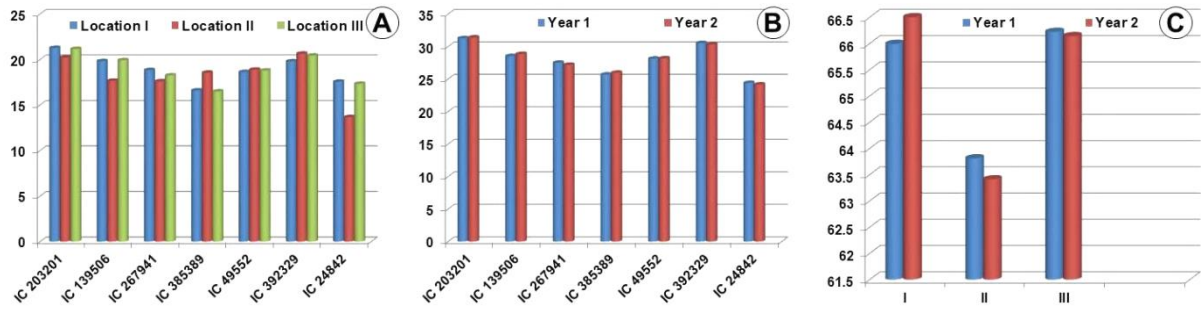

Figure 5. Mean performance under G x E interaction **A**, g, l and g x l; **B**, y and g x y; **C**, l x y [100 seeds weight (g)]

IC 203201 had the maximum value of 100 seeds weight in location I as well as III. IC 392329 exhibited the maximum value for 100 seeds weight in location II (Fig. 5A) among the other six accessions. In case of the phenotype 100 seeds weight the maximum value was exhibited by IC 203201 and the minimum value were for IC 24842 in both the years and among all the three locations studied (Fig. 5B). The highest value of 100 seeds weight was observed in Location III and Location I in year 1 and year 2 respectively (Fig. 5C).

Table 5. Number of pods per plant averaged over k=5 for 15 varieties of *Macrotyloma uniflorum* (Lam.) Verdc. [g x 1 x y x r data, replication totals and g x 1 x g totals]

REP	Location-1								Location -2								Location-3							
	Year 1				Year 2				Year 1				Year 2				Year 1				Year 2			
	I	II	III	∑	I	II	III	∑	I	II	III	∑	I	II	III	∑	I	II	III	∑	I	II	III	∑
IC 203201	39.2	41.2	36.4	116.8	40.2	42.4	39.0	121.6	41.6	42.0	39.6	123.2	36.8	37.6	38.8	113.2	38.6	39.4	36.8	114.8	42.2	44.4	41.2	127.8
IC 139506	32.0	30.8	29.2	92.0	28.4	27.2	26.6	82.2	30.4	31.6	28.0	90.0	28.4	26.8	27.6	82.8	28.4	29.4	30.6	88.4	31.6	29.6	32.0	93.2
IC 267941	35.6	37.6	38.0	111.2	38.2	39.4	40.8	118.4	32.4	31.2	33.6	97.2	28.4	31.4	30.6	90.4	33.4	32.6	34.4	100.4	30.8	31.6	28.8	91.2
IC 385389	31.4	30.6	29.2	91.2	31.6	32.0	31.4	95.0	26.8	28.6	27.2	82.6	27.2	26.6	28.8	82.6	26.8	27.4	28.6	82.8	26.0	28.2	25.0	79.2
IC 49552	38.4	39.2	40.6	118.2	37.2	36.6	38.8	112.6	39.6	41.8	43.0	124.4	42.0	41.4	40.4	123.8	37.6	38.8	36.6	113.0	35.6	39.2	40.0	114.8
IC 392329	19.6	17.2	18.4	55.2	17.0	16.0	18.6	51.6	14.8	15.6	16.4	46.8	13.4	12.6	15.8	41.8	18.4	19.4	20.4	58.2	21.6	18.0	18.6	58.2
IC 24842	29.4	28.4	27.2	85.0	30.4	30.8	29.8	91.0	31.2	32.6	32.0	95.8	31.4	32.6	33.0	97.0	25.2	26.0	24.2	75.4	27.2	28.0	28.6	83.8
∑	225.6	225.0	219.0	669.6	223.0	224.4	225.0	672.4	216.8	223.4	219.8	660.0	207.6	209.0	215.0	631.6	208.4	213.0	211.6	633.0	215.0	219.0	214.2	648.2

Table 6. Mean performance under G x E interaction. [Number of pods/plant]

Genotypes	**(A): g x l means**			**(B): g x y means**	
	L_I	**L_{II}**	**L_{III}**	**Y_1**	**Y_2**
IC 203201	39.733	39.400	40.433	39.422	40.289
IC 139506	29.033	28.800	30.267	30.044	28.689
IC 267941	38.267	31.267	31.933	34.311	33.333
IC 385389	31.033	27.533	27.000	28.511	28.533
IC 49552	38.467	41.367	37.967	39.511	39.022
IC 392329	17.800	14.767	19.400	17.800	16.844
IC 24842	29.333	32.133	26.533	28.467	30.200
Locations	**(C): l, y and l x y means**				
		Y_1		**Y_2**	**Mean**
I		31.89		32.02	31.96
II		31.43		30.08	30.76
III		30.14		30.87	30.51
Mean		31.15		30.99	

Genotypes	**(D): g and g x l x y means**						
	L_I		**L_{II}**		**L_{III}**		**Mean**
	Y_1	**Y_2**	**Y_1**	**Y_2**	**Y_1**	**Y_2**	
IC 203201	38.93	40.53	41.07	37.73	38.27	42.60	39.86
IC 139506	30.67	27.40	30.00	27.60	29.47	31.07	29.37
IC 267941	37.07	39.47	32.40	30.13	33.47	30.40	33.82
IC 385389	30.40	31.67	27.53	27.53	27.60	26.40	28.52
IC 49552	39.40	37.53	41.47	41.27	37.67	38.27	39.27
IC 392329	18.40	17.20	15.60	13.93	19.40	19.40	17.32
IC 24842	28.33	30.33	31.93	32.33	25.13	27.93	29.33

The different potentiality of genotype in various locations or among years is GEI (Fernandez 1991). When the interaction was partitioned amongst genotypes and locations the variability due to environments was greater than that due to genotypic differences because from the table it is prominent that no genotype stands its highest phenotypic expression all along in either of the locations and years.

The existence of G X E interaction has been revealed by lots of statistical approaches. Wade *et al.* (1996) reviewed the importance of and approaches to different environmental effects to establish the fact that G X E interactions influence plants. According to Allard & Bradshaw (1964), the phenotypic expression of a genotype is associated with its environment due to G X E interactions common in agricultural research. Some more examples of such studies include analysis of variance, regression (Finlay & Wilkinson 1963), non-parametric methods (Kang 1988, Fox *et al.*1990) and pattern analysis of multivariate analytical methods such as the additive main effects and multiplicative interaction (AMMI) model (Zobel *et al.*1988) and genotype plus G X E interaction (GGE) biplots (Yan *et al.* 2000). The phenotypic expression of a trait is influenced both by the environmental factors as well the genotype and this fact is indicated by the presence of G X E interaction. Breeders of not only animal but also plant biology uses this methodology to recognize and choose genotypes for desired environment. A large number of genotypes have been experimented across a diverse range of environments, including locations, years and seasons. Aucamp *et al*. (2006) and Bradbury *et al.* (2011) studied G X E interaction for the traits quality and biomass production respectively though the most common targeted trait for G X E interaction in case of plants is its yield. The G × E approach has been used to describe variation in root traits in tuberous plant species by Grüneberg *et al.* (2005) and Benesi *et al.* (2004) in sweet potato and cassava respectively. There are few published papers on G × E for root traits in cereals (Kondo *et al.* 2003).

Each and every organism has an inborn capacity (phenotypic plasticity) to change its phenotype in accordance with the ongoing changes of the environment. This ability to adapt to changes is different for different genotypes (Pigliucci 2005, El-Soda *et al*. 2014). Therefore, phenotypic traits can be altered by the interaction of genotype and environment (Via *et al.* 1995, Pigliucci & Hayden 2001, Nussey *et al.* 2007). Plants often come across different environmental conditions. The genetic makeup of plants underlies the responses to these interactions. Although occasional spontaneous mutations may occur, yet the genotype usually remains constant throughout the wide range of environments that an organism encounters every day in its life. A wide range of phenotypes may result when the same genotype is subjected to different environments. These phenotypic variations are attributable to the effect of the environment on the expression and function of genes influencing the trait. Changes in the relative performance of genotypes across different environments are referred to as genotype x environment interactions (GEI).

Table 7. 100 seeds weight (g) averaged over k=5 for 15 varieties of *Macrotyloma uniflorum* (Lam.) Verdc. [g x l x y x r data, replication totals and g x l x g totals]

REP	Location-1								Location -2								Location-3							
	Year 1				Year 2				Year 1				Year 2				Year 1				Year 2			
	I	II	III	∑	I	II	III	∑	I	II	III	∑	I	II	III	∑	I	II	III	∑	I	II	III	∑
IC 203201	3.52	3.56	3.57	10.65	3.55	3.53	3.54	10.62	3.33	3.38	3.36	10.07	3.40	3.39	3.36	10.15	3.51	3.53	3.50	10.54	3.54	3.53	3.55	10.62
IC 139506	3.26	3.23	3.27	9.76	3.37	3.32	3.36	10.05	2.95	2.98	2.94	8.87	2.93	2.91	2.95	8.79	3.30	3.31	3.29	9.90	3.32	3.33	3.36	10.01
IC 267941	3.14	3.11	3.18	9.43	3.11	3.16	3.13	9.40	2.98	2.93	2.97	8.88	2.88	2.90	2.94	8.72	3.08	3.06	3.05	9.19	3.07	3.01	2.98	9.06
IC 385389	2.73	2.68	2.71	8.12	2.84	2.81	2.83	8.48	3.10	3.12	3.08	9.30	3.09	3.06	3.10	9.25	2.74	2.77	2.75	8.26	2.71	2.79	2.73	8.23
IC 49552	3.09	3.12	3.07	9.28	3.10	3.11	3.14	9.35	3.16	3.19	3.13	9.48	3.12	3.15	3.13	9.40	3.13	3.11	3.12	9.36	3.14	3.13	3.16	9.43
IC 392329	3.31	3.36	3.29	9.96	3.28	3.25	3.30	9.83	3.41	3.45	3.47	10.33	3.43	3.45	3.43	10.31	3.40	3.41	3.43	10.24	3.38	3.40	3.41	10.19
IC 24842	2.96	2.93	2.90	8.79	2.91	2.94	2.92	8.77	2.28	2.31	2.29	6.88	2.28	2.27	2.24	6.79	2.91	2.88	2.94	8.73	2.87	2.85	2.88	8.60
∑	22.01	21.99	21.99	65.99	22.16	22.12	22.22	66.5	21.21	21.36	21.24	63.81	21.13	21.13	21.15	63.41	22.07	22.07	22.08	66.22	22.03	22.04	22.07	66.14

Table 8. Mean performance under G x E interaction [100 seeds weight (g)]

Genotypes	**(A): g x l means**			**(B): g x y means**	
	L_I	**L_{II}**	**L_{III}**	**Y_1**	**Y_2**
IC 203201	3.545	3.370	3.527	3.473	3.488
IC 139506	3.302	2.943	3.318	3.170	3.206
IC 267941	3.138	2.933	3.042	3.056	3.020
IC 385389	2.767	3.092	2.748	2.853	2.884
IC 49552	3.105	3.147	3.132	3.124	3.131
IC 392329	3.298	3.440	3.405	3.392	3.370
IC 24842	2.927	2.278	2.888	2.711	2.684

Locations	**(C): l, y and l x y means**		
	Y_1	**Y_2**	**Mean**
I	3.14	3.17	3.16
II	3.04	3.02	3.03
III	3.15	3.15	3.15
Mean	3.11	3.11	

Genotypes	**(D): g and g x l x y means**						
	L_I		**L_{II}**		**L_{III}**		**Mean**
	Y_1	**Y_2**	**Y_1**	**Y_2**	**Y_1**	**Y_2**	
IC 203201	3.55	3.54	3.36	3.38	3.51	3.54	3.480
IC 139506	3.25	3.35	2.96	2.93	3.30	3.34	3.188
IC 267941	3.14	3.13	2.96	2.91	3.06	3.02	3.037
IC 385389	2.71	2.83	3.10	3.08	2.75	2.74	2.868
IC 49552	3.09	3.12	3.16	3.13	3.12	3.14	3.127
IC 392329	3.32	3.28	3.44	3.44	3.41	3.40	3.382
IC 24842	2.93	2.92	2.29	2.26	2.91	2.87	2.697

CONCLUSION

Macrotyloma uniflorum is a legume which has high capacity to give yield in not only Burdwan but also Purulia. The data of the different metrical characters showed variations among genotypes as well as locations. The variability is greater due to environment than due to genotypes. This has established the fact that there exists an interaction between the genotypes and environments which is clear from the Comstock and Robinson model. Meteorological factors could not affect the yield as irrigation facilities were provided from time to time. IC 203201 proved to be the best yielder among the genotypes studied. All seven genotypes have more or less adequate potentialities to adapt and grow well by overcoming the micro-environmental factors. Though Purulia has a dry environment with lesser rainfall than Burdwan, yet the accessions sown were potential in terms of their yield. *Macrotyloma uniflorum* can withstand both types of environment. Being a legume with high content of protein it can be cultivated to meet the needs of people living in rainfed conditions also.

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