

RESEARCH ARTICLE

Ragi ATL 1- A New high Yielding, Sturdy Culm, Non- lodging Variety Suitable for Tamil Nadu

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ABSTRACT

A high yielding and early maturing ragi culture TNEc 1285 was developed at the Centre of Excellence in Millets, Tamil Nadu Agricultural University, Athiyandal, and released as ATL 1. It is a cross derivative of TNAU 900 × CO (Ra) 14 has recorded 3128 kg ha⁻¹ and 2879 kg ha⁻¹ under irrigated and rainfed conditions respectively. This culture has recorded an average yield of 3008 kg ha⁻¹ in 269 trials conducted from 2012 to 2020 and the yield is 13.3, 16.2, and 17.1 per cent higher than the checks CO 15 (2656 kg ha⁻¹), Paiyur 2 (2588 kg/ha) and GPU 28 (2569 kg/ha) respectively. It gave an average yield of 3183 kg ha⁻¹ in the station Trials, 2317 kg ha⁻¹ in Multi location Trials, 3004 kg ha⁻¹ in Adaptive Research Trials conducted by the Department of Agriculture, and 3061 kg ha⁻¹ in ARTs conducted by KVK's. The mean straw yield of TNEc 1285 is 4990 kg ha⁻¹, which is 13.7 percent increase over the checks CO15, 17.6 percent over Paiyur 2, and 20.5 percent over GPU 28. Ragi variety ATL 1 has 8 - 9 incurved fingers per ear head and 5 – 6 productive tillers per plant. It is endowed with special attributes like easy threshability, synchronized maturity and non-lodging growth habit. Regarding the seed quality, it is rich in protein (11.9 %) and calcium (325mg/100g) with the high flouring capacity (92 %) and low residual weight (8 %). Based on colour, appearance, flavour texture and taste ATL1 ragi variety is displayed favorable overall acceptability. This culture is moderately resistant to leaf, neck, and finger blasts. TNEc 1285 has been released as a new variety ATL 1 during 2020 for cultivation during *Kharif* season as rainfed crop in Erode, Salem, Dharmapuri and Krishnagiri districts and as irrigated crop during summer in Thiruvannamalai and Vellore districts of Tamil Nadu.

Keywords: Ragi; New variety ATL 1; Sturdy culm; Non- lodging variety

INTRODUCTION

Finger millet (*Eleusine coracana* L. (Gaertn) is a staple food for drought prone areas of the world and it is considered to be an important crop for food and nutritional security. Finger millet ranks fourth in importance among millets after sorghum, pearl millet, and foxtail millet (Krishnappa et al., 2007). In Tamil Nadu, finger millet or ragi is the most important traditional millet grown over an area of 0.78 lakh hectare with the highest productivity of 3257 kg ha⁻¹ and provides food and nutritional security to the marginal farmers in the rainfed drylands and hilly tribal areas. (Anonymous, 2005). It is a hardy crop with minimum disease and pest problems and assures reasonable economic return even under adverse growing conditions. The great merit of finger millet is that it can be stored for more than ten years without deterioration and

insect damage. It has traditionally played an important role as "Famine Reserve crop". It is also considered to be free of major pests and diseases. It has been found that the protein of finger millet is biologically complete as in the case of milk. In addition, high calcium, high soluble fibre and polyphenol, high diastolic power of malted grains coupled with starch that is more resistant to hydrolysis than of other cereals, accord finger millet a unique status among foodgrains (Kalloo, 2004). Thus, finger millet can be used for producing a variety of nutritionally designed foods for infant feeding and also prepare a variety of nutritionally rich foods for adults. Further, there is a great demand for finger millet due to an increase in the number of diabetic patients. Generally, lower yields of finger millet are due to a lack of high-yielding varieties and the unadoption of improved cultural

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practices by the farmers in dry land farming. There is a need to improve the genetic yield potentiality and evolve new high-yielding varieties with heat and drought tolerance, suitable for ragi growing areas. Keeping this objective, breeding work was initiated to increase the production and productivity of finger millet in Tamil Nadu.

MATERIAL AND METHODS

The proposed Ragi culture TNEc 1285 was evolved at the Centre of Excellence in Millets, Athiyandal. The crosses were made between TNAU900 × CO(Ra) 14 followed by pedigree selection method. The elite plants were selected from F2 onwards and they were evaluated for their sustained yield ability and homozygosity. The culture TNEc 1285 was evaluated with checks at Millet breeding station, Coimbatore starting from 2012 to 2015, multi-location trials during 2015- 2017, Adaptive research trials during 2017-2019, on-farm trials during 2017-2020 in farmers' holdings at various districts of Tamil Nadu. Thus, a total of 269 trials were conducted. Besides, the reaction of the culture against important pests and diseases was screened per the standard scale, and also as per the standard procedures the grain qualities were analyzed.

RESULTS AND DISCUSSION

The overall performance of the Ragi culture TNEc 1285 in different trials was presented in Table 1. A total of 269 trials were conducted and the culture has given the mean grain yield of 3008 kg ha⁻¹ which is 13.3 % and 16.2 % increase yield than the checks CO 15 and paiyur 2. The mean straw yield of 4990 kg ha⁻¹ was recorded and this was 13.7 % and 17.6 % more yield than CO 15 and Paiyur 2 respectively (Table 1).

Station trail was conducted from *Kharif* 2012 to *Kharif* 2015, the culture recorded a mean grain yield of 3183 kg ha⁻¹ which was a 13.3% per cent increase over CO 15 and 16.4 per cent increase over Paiyur 2, and 17.1 percent increase over GPU 28, and a mean straw yield of 5665 kg ha⁻¹ which was 13.7% per cent increase over CO 15 and 17.6 per cent increase over Paiyur 2 and 20.5 percent increase over GPU 28 (Table 2).

The performance of ragi culture TNEc 1285 was tested in rainfed conditions from *kharif* 2012 to *kharif* 2014, the culture recorded the grain yield of 2976 kg ha⁻¹ which is 23.7% and 32.9% increased yield than CO 15 and Paiyur 2 and the straw yield was 4889 kg ha⁻¹ which is 17.2% and 24.1% and 25.6% increased than CO 15, Paiyur 2 and GPU 28 respectively. Under irrigated conditions this culture recorded the mean grain yield of 3390 kg ha⁻¹ which is 22.7%, 33% and 29.2% increased yield than the check varieties CO 15, Paiyur 2, and GPU

28 respectively. The straw yield under irrigated conditions is 6440 kg ha⁻¹ which is 24.7%, 38.1% and 44.4% increased yield than the check varieties CO 15, Paiyur 2, and GPU 28 respectively (Table 2).

Multi Location trials were conducted during *kharif* 2015-17; the culture recorded a mean grain yield of 2317 kg ha⁻¹ with 15.5% and 16.5 % increases over CO 15 and Paiyur 2 respectively. The culture recorded the mean straw yield of 4066 kg ha⁻¹ which is 9.9 % and 13.5 % increase yield over CO 15 and Paiyur 2 respectively (Figure 1 and Figure 2).

Ragi culture TNEc 1285 was tested in Adaptive Research Trail during 2017-19 at 70 locations at farmers' fields and recorded the grain yield of 3004 kg ha⁻¹ and 4755 kg ha⁻¹ of straw yield. A total of 65 trials were conducted in KVK, the culture recorded the mean grain yield of 3061 kg ha⁻¹ and straw yield of 5149 kg ha⁻¹. From the mean of 135 trials, TNEc 1285 ragi culture recorded the mean grain yield of 3033 kg ha⁻¹ which is 13.3 and 15.85% increased yield than CO 15 and Paiyur 2 respectively. The mean of straw yield from the 135 trials of ART is 4952 kg ha⁻¹ which is 13.36% and 16.57% increased yield than the check varieties CO 15 and Paiyur 2 respectively (Figure 3).

On farm trials was conducted under rainfed condition during *kharif* 2017-2020, the culture recorded mean grain yield of 3007 kg ha⁻¹ of grain yield which is 13.4 %, 15.6% more yield compared with the checks viz., CO 15 and PYR 2 respectively. Straw yield is 4975 kg ha⁻¹ which is 19.6 and 31.4% increased yield compared with the checks viz., CO 15 and PYR 2 (Table 3).

The performance of TNEc 1285 was tested in on farm trials under irrigated condition. A total of 109 trials were conducted from *rabi* 2017 to *rabi* 2020. The culture recorded the mean grain yield of 3083 kg ha⁻¹ which is 10.5% and 11.3% increased yield than the check varieties CO 15 and Paiyur 2. The mean straw yield of 4367 kg ha⁻¹ was recorded which is 15.4%, 23.4% and 26.9% increased yield than the check varieties CO 15, PYR 2 and GPU 28 (Table 4).

Large scale Demonstrations was done from *kharif* 2017 to *kharif* 2020 at rainfed condition at Centre of Excellence, Athiyandal. TNEc 1285 recorded 3442 kg ha⁻¹ of grain yield which is 7.6%, 10.6% and 9.7% more yield compared with check CO 15, PYR 2 and GPU 28. Straw yield is 5255 kg ha⁻¹ which is 10.4% and 9.0% more yield compared with the checks viz., Paiyur 2 and GPU 28 (Figure. 4).

Under irrigated condition large scale demonstrations was done from *rabi* 2017 to *rabi* 2020. The culture recorded the mean grain yield of 3442 kg ha⁻¹ which is 7.6%, 10.6% and 9.7% more yield compared with the checks viz., CO 15, PYR 2 and GPU 28. The straw yield of 5255 kg ha⁻¹ which is 10.4 and 9.0% more yield ha⁻¹ compared with the checks viz., PYR 2 and GPU 28 (Figure. 5).



Table 1. Overall performance of Ragi culture TNEc 1285 under various trials

Name of the Trials	No. of trials	Grain Yield (kg/ha)				Straw Yield (kg/ha)			
		TNEc 1285	CO 15 *	Paiyur 2*	GPU 28*	TNEc 1285	CO 15 *	Paiyur 2*	GPU 28*
Station Trials (2012-2015)	6	3183	2584	2394	2452	5665	4669	4301	4176
MLT (2015 - 2017)	12	2317	2006	1989	2200	4066	3701	3583	3568
ART (2017-2019)	70	3004	2602	2530	2361	4755	4092	4064	-
ART - KVK (2017 - 2019)	65	3061	2749	2706	-	5149	4488	4432	-
On Farm Trials (2017-2020)	109	3066	2764	2813	2735	4987	4299	4344	4072
Large Scale Demonstrations (2017-2021)	7	3418	3230	3096	3096	5320	5092	4739	4753
Mean of 269 trials		3008	2656	2588	2569	4990	4390	4244	4142
% Increase over		-	13.3	16.2	17.1	-	13.7	17.6	20.5

* Check

*Significant at 5% level of confidence

Table 2. Performance of Ragi culture TNEc 1285 in Station Trials (2012-2015)

Table 2: Performance of Rice Culture TNEc 1285 in Station Trials (2012-2015)								
Year	Grain Yield (kg/ha)				Straw Yield (kg/ha)			
	TNEc 1285	CO 15 *	Paiyur 2 *	GPU 28*	TNEc 1285	CO 15 *	Paiyur 2 *	GPU 28*
Rainfed								
Kharif, 2012	3002	2630	2468	2540	4998	4340	4120	4200
Kharif, 2013	3245	2445	2410	2380	5120	4205	4207	3980
Kharif, 2014	2680	2140	1840	1920	4550	3975	3490	3500
Mean	2976	2405	2239	2280	4889	4173	3939	3893
% Increase over	-	23.7	32.9	30.5	-	17.2	24.1	25.6
Irrigated								
Rabi, 2012-13	3558	3047	2892	2936	6760	5698	5292	4991
Rabi, 2013-14	3715	2828	2743	2832	7059	5288	5020	4814
Rabi, 2014-15	2896	2413	2010	2103	5502	4512	3678	3575
Mean	3390	2763	2548	2624	6440	5166	4663	4460
% Increase over	-	22.7	33.0	29.2	-	24.7	38.1	44.4
Overall Mean (6 Trials)	3183	2584	2394	2452	5665	4670	4301	4177
% Increase over	-	23.2	33.0	29.8	-	21.3	31.7	35.6

* Check

Table 3. Performance of TNEc 1285 in On Farm Trial (2017-20) under rainfed condition

Sl. No	Districts	No. of Trials	Grain Yield (kg/ha)					Straw Yield (kg/ha)				
			TNEc 1285	CO 15*	PYR 2*	GPU 28*	ML 365*	TNEc 1285	CO 15*	PYR 2*	GPU 28*	ML 365*
Kharif, 17												
1	Dharmapuri	12	2301	2121	2154	-	-	3896	3524	3601	-	-
2	Krishnagiri	4	3370	2810	2790	-	-	5545	4306	3370	-	-
	Mean (16 Trials)		2836	2466	2472	-	-	4721	3915	3486	-	-
	% increase over		-	15.0	14.7	-	-	-	20.6	35.4	-	-
Kharif, 18												
1	Dharmapuri	8	2506	2121	2070	-	-	4132	3186	3259	-	-
2	Krishnagiri	16	3285	2864	2812	-	-	5274	4322	4407	-	-
	Mean (24 Trials)		2896	2493	2441	-	-	-	4703	3754	3833	-
	% increase over		-	16.2	18.6	-	-	-	-	25.3	22.7	-
Kharif, 19												
1	Dharmapuri	4	3049	2876	2739	2952	2973	5118	4689	4457	4157	4447
2	Krishnagiri	4	3447	3172	3066	3165	3152	5613	4943	4660	4876	4832
	Mean (8 Trials)		3248	3024	2903	3059	3063	5366	4816	4559	3248	3024
	% increase over		-	7.4	11.9	6.2	6.0	-	11.4	17.7	65.2	77.4
	Overall Mean (48 Trials)		3007	2652	2602	3059	3063	4975	4159	3787	3248	3024
	% increase over		-	13.4	15.6	-1.7	-1.8	-	19.6	31.4	53.2	64.5

* Check

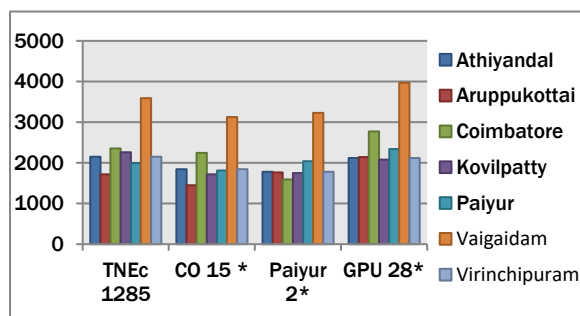


Fig. 1: Grain Yield (kg/ha)

Two years (2015 – 2017) MLT data of Ragi culture TNEc 1285 (12 locations)

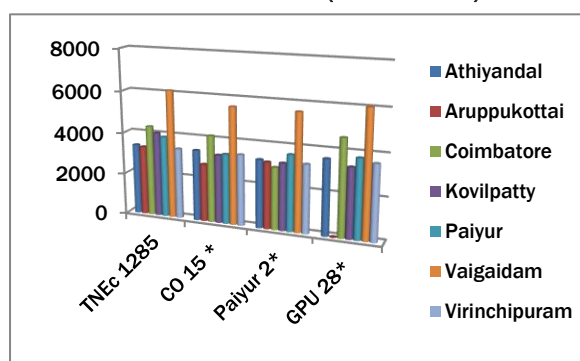


Fig. 2: Straw Yield (kg/ha)

Two years (2015 – 2017) MLT data of Ragi culture TNEc 1285 (12 locations)

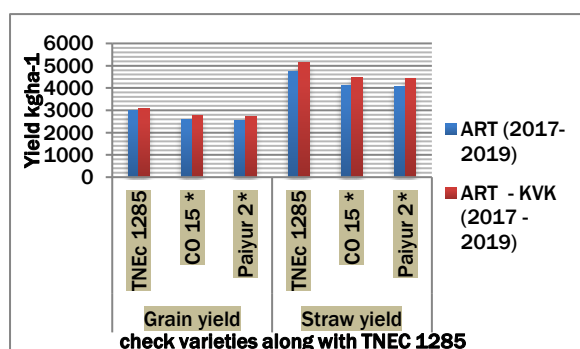


Fig. 3: Performance of TNEc 1285 in ART during 2017-20

Regarding the seed quality, it is rich in protein (11.9 %) and calcium (325 mg/100g) with a high flouring capacity (92 %) and low residual weight (8 %). Based on colour, appearance, flavour texture, and taste. TNEc 1285 displayed favorable overall acceptability. Regarding grain quality characteristics, Ragi culture TNEc 1285 excels in the check varieties and was found to be the best during cooking and sensory evaluations. (Table 8).

Regarding grain and fodder quality characteristics, Ragi culture TNEc1285 excels in the check varieties. The culture recorded the crude protein of 8.4%, and crude fibre of 20.8% with rich in potassium, Phosphorus and mineral matter. (Figure 7)

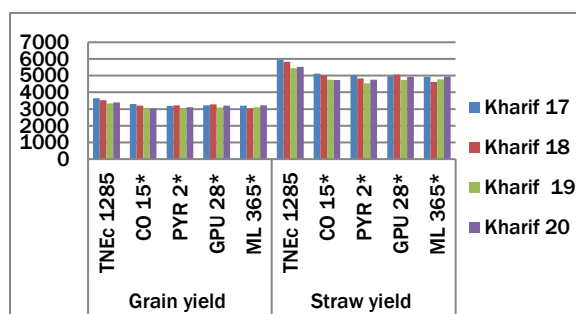


Fig. 4: Large Scale Demonstration (Rainfed): Centre of Excellence in Millets, Athiyandal.

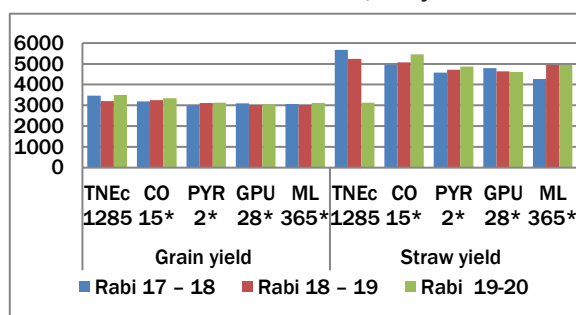


Fig. 5: Large Scale Demonstration (Irrigated): CEM, Athiyandal

Ragi culture TNEc 1285 recorded less incidence of leaf blast among all the entries. Similarly, neck and finger blasts are also recorded as less in TNEc 1285 when compared with the check varieties. Overall performance of the culture TNEc 1285 under in vitro and in vivo conditions is moderately resistant to all three types of blasts and resistant to brown spot and grain mold diseases (Figure 6).

The grains are bold and attractive golden yellow in colour. The grains are nutritious with preferred grain qualities for cooking and value addition. The nutrient rich straw is palatable and highly suitable for cattle feeding. With high bulk density and milling out turn, the proposed variety is preferred by consumers and entrepreneurs.

Though there is no major incidence of pests in ragi, the damages caused due to aphids, grasshopper, earhead caterpillar, weevil, and stem borer are minimum and are within the economic threshold level (Table 7).



Table 4. Performance of TNEc 1285 in On Farm Trial (2017-20) under irrigated condition

S. No	Districts	No. of Trials	Grain Yield (kg/ha)					Straw Yield (kg/ha)				
			TNEc 1285	CO 15*	PYR 2*	GPU 28*	ML 365*	TNEc 1285	CO 15*	PYR 2*	GPU 28*	ML 365*
Rabi, 17 -18												
1	Vellore	9	2597	2389	2360	-	-	4274	3746	3646	-	-
2	Thiruvannamalai	8	2650	2401	2322	-	-	4277	3620	3557	-	-
	Mean (17 Trials)		2624	2395	2341	-	-	4276	3683	3602	-	-
	% increase over		-	9.6	12.1	-	-	-	16.1	18.7	-	-
Rabi, 18 -19												
1	Vellore	8	3440	3078	3077	-	-	5650	4902	5040	-	-
2	Thiruvannamalai	4	3459	3436	3163	-	-	5478	5353	4935	-	-
	Mean (12 Trials)		3450	3257	3120	-	-	5564	5128	4988	-	-
	% increase over		-	5.9	10.6	-	-	-	8.5	11.5	-	-
Rabi, 19 -20												
1	Vellore	4	3496	3222	3130	3168	3099	5642	5071	4663	4884	4758
2	Thiruvannamalai	28	3312	3052	2966	2921	3002	5287	4757	4445	4500	4583
	Mean (32 Trials)		3404	3137	3048	3045	3051	5465	4914	4554	4692	4671
	% increase over		-	8.5	11.7	11.8	11.6	-	11.2	20.0	16.5	-
	Overall Mean (61 Trials)		3159	2930	2836	3045	3051	5102	4575	4381	4692	4671
	% increase over		-	7.8	11.4	3.7	3.5	-	11.5	16.5	8.7	-
	Overall Mean (2017-20) (109 Trials)		3083	2791	2719	3052	3057	5039	4367	4084	3970	3848
	% increase over		-	10.5	11.3	1.0	0.8	-	15.4	23.4	26.9	-

Table 5. Disease reaction of Ragi culture TNEc 1285 under field condition

S. No	Entries	Leaf blast (G)	Leaf blast PDI (%)	Neck blast (%)	Finger blast (%)	Brown Spot (G)	Grain mold (G)
CEM, Athiyandal							
1.	TNEc 1285	0.67	8.50	4.00	1.25	1.00	2.50
2.	CO 15*	4.67	24.50	12.00	8.75	2.00	4.50
3.	Paiyur 2*	5.00	26.00	16.00	12.50	3.00	3.50
4.	GE4449 (R)	1.00	18.00	6.50	2.50	1.00	1.00
5.	Udurumallige (S)	8.33	88.50	44.00	38.50	3.67	5.00
Department of Millets, Coimbatore							
1.	TNEc 1285	1.66	9.67	0.0	0.0	0.0	0.0
2.	CO 15*	5.66	21.12	15.56	17.89	0.0	0.0
3.	Paiyur 2*	2.66	12.23	0.0	0.0	0.0	0.0
4.	GE4449 (R)	1.00	0.0	0.0	0.0	0.0	0.0
5.	Udurumallige (S)	7.33	86.67	28.85	31.12	0.0	0.0

Table 6. Performance of TNEc 1285 in On Farm Trial (2017-20) under irrigated condition

S. No.	Genotype	Aphids (20 DAS) Infested plants (%)	Aphids (50 DAS) Infested plants (%)	Stem borer (Tillering stage) (% Dead heart)	Stem borer (Panicle stage) (% White Ear Head)
1	TNEc 1285	2.11	3.71	2.39	1.83
2	CO 15*	4.21	5.16	5.43	4.60
3	Paiyur 2*	3.40	5.51	6.13	3.27

Table 7. Grain and quality characteristics of Ragi culture TNEc 1285

S.No	Quality characteristics	TNEc 1285	CO 15*	PYR 2*	GPU 28*
a)	Nutritional Quality characters				
1.	Crude protein (%)	11.9	11.8	11.3	10.2
2.	Crude fat (%)	1.5	1.3	1.0	1.8
3.	Crude fiber (%)	25	26	32	32
4.	Calcium (mg/100g)	325	301	295	295
b)	Sensory evaluation score (1-10 score)				
1.	Colour & appearance	9	8	6	8
2.	Flavour	10	10	8	8
3.	Texture	9	8	8	8
4.	Taste	10	10	8	6
5.	Overall acceptability	9.5	9	7.5	7.5
c)	Flouring capacity				
1.	Initial weight (g)	500	500	500	500
2.	Final weight (g)	460	455	430	440
3.	Residues weight (g)	40	45	70	60
4.	Flouring capacity (%)	92	91	86	88

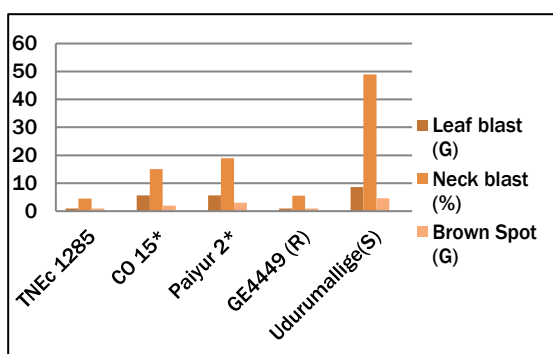


Fig. 6: Disease reaction of Ragi culture TNEc 1285 under controlled condition

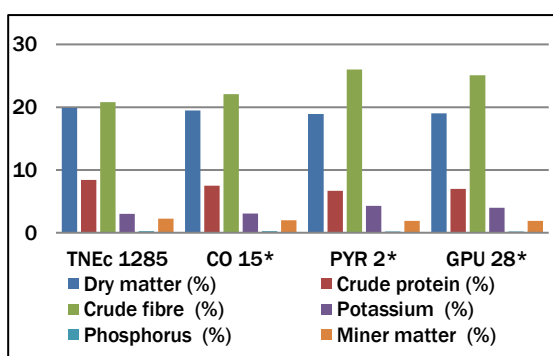


Fig. 7: Fodder quality characteristics of Ragi culture TNEc 1285

The culture TNEc 1285 has 8 - 9 incurved fingers per earhead and 5 - 6 productive tillers per plant. It is endowed with special attributes like easy thresh ability, synchronized maturity, and non-lodging growth habit. The proposed ragi culture TNEc 1285 has strong and sturdy culm with long and semi-compact panicles. It is drought tolerant, early duration, blast resistant, compact ear head, input responsiveness, synchronous maturity, non-shattering, and non-lodging characters. Acceptable to farmers, due to its high grain and straw yield, compact ear head, input responsiveness, synchronous maturity, non-shattering and non-lodging characters. Nutrient-rich straw is palatable, valuable, and relished by animals. Acceptable to consumers for its favorable cooking qualities, grain colour, flavor, taste, and texture. Acceptable to industries based on grain nutritional value and its suitability for value addition.



Field view of TNEc 1285 as ATL 1

CONCLUSION

In view of stable yield performance across seasons and locations and special attributes, with drought tolerance, the ragi culture TNEc 1285 is recommended for release by Crop Scientists Meet – Millets 2020 by TNAU, Coimbatore and released as ATL 1 by SVRC during 2020 for rainfed and irrigated conditions in Dharmapuri, Thiruvannamalai, Vellore, Salem and Krishnagiri districts of Tamil Nadu under rainfed condition.

REFERENCES

- Anononymous 2005. *Annual progress report All India Coordinated small millet improvement project*. **BR 3- BR 12**.
- Kallo.G (2004). Characterization of Exotic and Indigenous finger millet germplasm of Uttaranchal hills, *technical Bulletin* **22 (2/2004)**. **PP 1-3**.
- Krishnappa, M.Ramesh, S.Chandraprakash, J.Jayaram Gowda, Bharathi and Dayal Doss D. 2009. Genetic analysis of economic traits in finger millet. *SAT e journal- December 2009/Volume 7 an open access journal published by ICRISAT*.