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Prafull Kumar
SGCARS, Jagdalpur, IGKV, Raipur, Chhattisgarh, India

Narendra Kumar
SGCARS, Jagdalpur, IGKV, Raipur, Chhattisgarh, India

PS Netam
SGCARS, Jagdalpur, IGKV, Raipur, Chhattisgarh, India

AK Thakur
SGCARS, Jagdalpur, IGKV, Raipur, Chhattisgarh, India

Corresponding Author:
Prafull Kumar
SGCARS, Jagdalpur, IGKV, Raipur, Chhattisgarh, India

Genetic potential assessment of elite finger millet (*Eleusine coracana* L.) genotypes in rainfed upland farming system

Prafull Kumar, Narendra Kumar, PS Netam and AK Thakur

Abstract
The biannual field experiment was conducted during *kharif* 2018-19 and 2019-20 crop season at New Upland Research cum Instructional Farm, SG College of Agriculture and Research Station, Lamker, IGKV, Raipur, Chhattisgarh, India. The objective of study was to find out phenological parameters having significant role in regulation and expression of potent grain yield under rainfed agroecology. Beginning from tillering potential, Genotypes IC0477650, GEC352, IC0476864 and GEC280 was found to be good as being parallel to check varieties over the seasons. Regarding fingers per ear, two genotypes (GEC122, IC0477620) showed nine fingers; two (IR-01, GEC137) showed eight fingers; seven (IC0477650, IC0476838, GEC79, GEC400, IC0477317, GEC280 and IC0476663) displayed seven fingers. With respect to test weight, accessions IC0477406 (3.71g), GEC79 (3.61g), GEC400 (3.59g), IC0477650 (3.38g), GEC69 (3.31g), GEC122 (3.23g), GEC371 (3.18g), GEC132 (3.03g), GEC274 (3.021g) and IC0477317 (2.99g) were found overall promising for selection of grain yield. Referring to grain yield per plot, GPU67 was at first position numerically but (CD ≤ 7.396 q ha $^{-1}$), it was similar to IC0476838, IC0477406 and GEC122. Similarly other checks i.e., GPU 28 and IR-01 were statistically similar with GEC371, IC0476663, GEC348, IC0477591, GEC122 and IC0477406 at same level of critical difference. Therefore, genotypes IC0476838, IC0477406, GEC122, GEC371, IC0476663, GEC348 and IC0477591 are concluded to be outcome of research and are suggested to evaluate in further varietal evaluation programme.

Keywords: Agriculture, finger millet, climate uncertainty, adaptability, grain yield

Introduction

Millets are cereal crop belongs to Poaceae grass family and some researchers have considered this as oldest cultivated crops (Hassan *et al*., 2021) [15]. Among all, including course and small millets, Pearl millet (*Pennisetum glaucum*) and finger millet (*Eleusine coracana*) are two well scientifically known and explored major millets used for food and feed. Pearl millet is believed to have originated from sub-Saharan Africa, and finger millet from the sub-humid uplands of East Africa. The two account for most of the world's millet production and trade (Anonymous, 2017). The majority of recent research and agricultural programmes, which are routed towards the development of millets, have been dedicated to pearl millets whereas, finger millet still need a professional attention towards scientific ideas and farming reforms. It is believed that finger millet should be directed instead of maize and other crops due to its ability and ecologically well matched with semi-arid areas in terms to tolerate drought. They are considered tough crops with respect to growth requirements as they withstand harsh climatic factors such as unpredictable climate and nutrient-depleted soils. In surprisingly contrast nature, finger millet also has capability to grow better in colder areas that have slightly more rain (Tadele, 2016) [28]. According to several researchers, millets can be an important source of essential nutrients such as amino acids, mineral and trace elements (Anitha, 2019) [3]. These include, but not limited to, an increase in digestive system well-being, a reduction in cholesterol, the prevention of heart disease, protection against diabetes, the lowering of cancer risks, and an increase in energy levels and improvement of the muscular system (Sobana *et al*., 2009; Amadou *et al*., 2013; Devi *et al*., 2014) [26, 2, 9]. It is also considered one of the crops that can provide good nutrition and income to small-scale farmers (Gowda *et al*., 2015; Hasan *et al*., 2021) [13, 15] and thus, contributes to livelihoods and the availability of food.

This variable climate friendly and nutritionally gifted grains are in perfect position to take the status of alternative crop; but due to lack of attention finger millet (in fact all millets) were neglected like a 'lost crop' (Anonymous, 2017). However current agricultural encounters with sustainable food production, climate change, water scarcity, multiple population growth and changing life style have compelled policy makers to look towards this older grain. This is providing an opportunity for farmers, nutritionists, and food and feed manufacturers to engage in small millets research in order to understand the nutritional and functional charm of this eco-friendly crop species.

Materials and Methods

The biannual field experiment was conducted during *kharif* 2018-19 and 2019-20 crop season at New Upland Research cum Instructional Farm, SG College of Agriculture and Research Station, Lamker, IGKV, Raipur, Chhattisgarh, India. A total number of 30 elite germplasm accessions along with four check varieties namely Indira Ragi 01, CG Ragi 02, GPU-28 and GPU-67 were evaluated for grain yield and adaptability to Bastar plateau agroecological zone. In each crop season tri-replicated experiment was framed in Randomized complete block design to reduce the experimental error and manage soil heterogeneity. In each replication, each entry was planted in a plot of 3x2.25m, where planting geometry was maintained at 22.5x10cm. Each plot was represented by 10 rows. Hand sowing was done at first fortnight of July and rest of procedure were followed as per standard recommendation for the crop. The observations were recorded for major grain yield contributing factors only like days to 50 percent flowering (DAS), tillers per plant, finger per ear, test weight (g) and grain yield per plot (g). 50 percent flowering were recorded when, half of the plants of individual plot displayed flowering, while tillers and finger count were noted down at maturity stage of crop. During the harvesting of crop, net plot harvest was included in grain per plot estimation to avoid the border row effects. For net plot harvesting, one row from each side was discarded to make the ultimate plot size at 3.0x1.80m (net plot size) and all further calculation was done with this measurement only. The raw data was subjected to statistical analysis following the RCBD using the software OPSTAT developed by O P Sheoran (1998).

Results and discussions

Days to 50 percent flowering

There is raising concern to break the yield barriers of economically important crop species through new technologies and visionary crop improvement approaches. Apart from high throughput molecular insights, phenological development of a plant is highly important to crop production in both generative and vegetative crops. The nature and timing of flowering for plant's requirement and responsiveness to vernalization are major factors in regional climatic adaptation of elite germplasm. Many genes are reported to control flowering behaviour through photoperiodism, vernalization etc., also reported to have impact on final grain yield (Mallik *et al*., 2018) [20]. In all seed producing crops floral transition is the key developmental switch that determines the dry matter production (Roux *et al*., 2006) [25]. Flowering involves the conversion of the apical meristem into a floral meristem from which all the parts of the flower will be produced Signals that change the fate of the apical meristem are maturity of the plant, temperature, production of gibberellin hormones and photoperiod (Jung and Mullert, 2009) [16].

In first experimental year (i.e., *kharif* 2018-19) the local check, IR-01, showed vary late flowering (91 DAS) which was according to its genetic nature. The remainder late maturing entries were GEC122 (88 DAS), CG-Ragi 02 (85 DAS), GEC322 (85 DAS), GEC280 (85 DAS), GEC296 (84 DAS), GPU-67 (84 DAS) and GEC69 (83 DAS). Whereas, GEC132 (56 DAS), IC0477406 (61 DAS), GEC270 (66 DAS), GEC348 (67 DAS), IC0476707 (67 DAS), IC0477317 (68 DAS), GEC400 (71 DAS), GEC137 (72 DAS) and IC0476663 (72 DAS) were recorded as early flowering under current crop season. In *kharif* 2019-20, almost similar pattern was seen for the flowering period, where it ranged between 56 to 96 DAS with an average of 73 DAS. Perusal of Table 01 revealed that late flowering genotypes of previous season took almost similar time to flower and the descending ranking was changed only little but, in contrast variation was seen for the genotypes which flowered vary early. In *kharif* 2019-20, IC0477591 (56 DAS), GEC132 (58 DAS), GEC296 (58 DAS), IC0477620 (59 DAS), IC0476378 (60 DAS), GEC348 (61 DAS), GEC280 (63 DAS), GEC371 (64 DAS) and IC0477890 (69 DAS) exhibited early flowering which deviated from previous crop season. The variation could belong to rainfall frequency during vegetative period, temperature alteration, soil fertility levels and some genetic factors which act in interaction with the prevailing environments. Earlier selection for flowering time traits were based on plant phenotype and relied on natural variation existing in primary and secondary gene pool of concerned crop species. However, presently many floral regulatory genes have been identified, their sequences can be used by breeders as functional markers for selecting favourable genotypes, for quality control of seed lots or for targeted manipulation of flowering traits by genetic modification (Roux *et al*., 2008) [25].

Tillering potential and optimum tillering

All members of Poaceae family germinates as single culm seedling and after the seedling stage it produces primary, secondary and tertiary tillers. Tillering potential is varietal feature and depends mainly on duration and morphology (Mohanan and Mini 2008) [21]. As per literature, optimum tillering facilitates synchronous flowering, maturity and uniform panicle (or economical reproductive unit) size (Khush 2000; Pawar *et al*., 2016) [17, 24]. The conventional concept that high tillering rice plants produce more yields is being replaced by a new plant type concept. The optimization of tillering is more important to produce more yields (Mohanan and Pavithran 2007) [22]. Genotypes with lower tiller number produce a larger proportion of heavier grains are also in reports (Kumar *et al*., 2016 and 2017). In *kharif* 2018-19, GPU-28, IC0476864, GEC352, IC0476378, GPU 67, CG-Ragi 02, IC0477650, GEC69 and GEC280 showed a similar number of three tillers. While genotypes, including local check IR-01, GEC11, IC0477591, GEC79, GEC371, GEC106, IC0477890, GEC122, GEC400 and some other genotypes recorded average number of two tillers. Five genotypes viz., GEC296, GEC348, IC0477317, GEC322 and GEC270 showed only tiller might be due non-responsiveness to prevailing environment. In next cropping season, tillers ranged from 01 to 03, where nine genotypes (GEC106, GEC280, IC0477650, GEC274, GEC352, GEC137, IC0476663, IC0477591 and GPU 67) exhibited three tillers, sixteen genotypes (GEC41, IC0477620, IC0476864, GEC348, IC0477406, CG-Ragi 02, IC0477890, GEC11, GEC270,

GEC132, GPU 28, IR-01, IC0476378, GEC69, IC0476838 and GEC79) produced two tillers and rest (seven genotypes namely GEC371, GEC322, GEC296, GEC122, IC0476707, GEC400 and IC0477317) had only one tillers. Concluding both the years data, IC0477650, GEC352, IC0476864 and GEC280 can be considered as vary good regarding the trait along with the check varieties like GPU 28, GPU 67 and CG-Ragi 02. It should be noted that, in both the experimental phase the tillers count was quite lesser in number compare to wheat, rice or other grasses, the major reason behind this is... a) rainfed cultivation in upland areas b) poor soil fertility and organic content and c) non-responsiveness of soil to inorganic fertilizers. Therefore, lower number of tillers should not be exaggerated with other crop species. However, despite of above tillering nature, finger millet produces a significant bulk quantity of grain under upland and dryland agriculture (discussed in detail later).

Fingers per ear (Unique feature of finger millet)

The inflorescence of finger millet (termed as “ear”) is a whorl of 2-11 digitate, straight or slightly curved spikes (termed as “finger”). The spike is 8-15cm long and 1-2cm broad. In each spike, 50-70 panicoid spikelets are arranged alternatively on the side of rachis. Each spikelet contains 3-13 florets. The florets are covered by two large barren leaves each being enclosed between a pair of scale known as palea. The florets are in the axil of lower flowering glumes known as lemma, which carries small appendages (Gupta *et al*., 2012) [14]. Coming to manuscript theme, fingers or spikes of finger millet is very important feature in regulation of final economic yield because, this only provides the space and harbours the grains over it. Theoretically it can be said “longer the finger, higher the grain count”. In our study finger number ranged between 5 to 7 (mean over replications) in *kharif* 2018-19, where seven genotypes (IC0476663, IC0477406, IR-01, IC0476378, IC0477317, IC0477620 and GEC122) possessed maximum number of fingers. Fourteen genotypes including three check varieties (GEC69, GEC137, GPU 28, CG-Ragi 02, GEC11, GEC352, IC0476864, GPU 67, IC0477890, GEC371, IC0477650, IC0476838, GEC79 and IC0477591) had six fingers in each ear. Among the genotypes which recorded lower number of fingers were GEC322, GEC274, GEC280, GEC41, IC0476707, GEC400, GEC106, GEC296, GEC348, GEC270 and GEC132. In next experimental season (i.e., *kharif* 2019-20) up to nine tillers were recorded at maximum and four at the other corner, which ascertain the role of environment and their interaction with genotypes. Among germplasm and check varieties two (GEC122, IC0477620) showed nine fingers; two (IR-01, GEC137) showed eight fingers; seven genotypes (IC0477650, IC0476838, GEC79, GEC400, IC0477317, GEC280 and IC0476663) displayed seven fingers; ten genotypes (IC0476378, GEC371, IC0477406, GEC69, GEC274, IC0476864, GEC41, GEC132, GEC296, GEC348, GPU 67) had six fingers. Among lower finger producing genotypes in second generation of evaluation nine genotypes (GEC11, GEC106, IC0477591, CG-Ragi 02, IC0477890, IC0476707, GEC270, GEC352, GPU 28 and GEC322) had five fingers in number and genotype GEC322 exhibited lowest four finger in entire experimental set. Literature states that there are fingers per ear has clear and dominant role in grain yield determination (Anuradha *et al*., 2013; Owere *et al*., 2015; Chavan *et al*., 2020) [4, 23, 6]. However, we observed that the trait is highly influenced by varying environmental parameters and therefore, we suggest to consider finger count in association with finger length, number of grains per ear and test weight. The reason is long sized finger may or may not have all filled grains; even if all grain filled, the grain weight may vary. Similarly, small sized finger may carry heavy seeds over it with compact filling of all grains.

Estimation of Test weight (g)

Test weight is an important predictor for milling of yield; test weights are measured on grain loads by weighing a known volume of grain, which is used to compare grain densities. If lower test weights than the accepted standard are recorded than more grain volume is needed for storage or transportation. If high test weights are recorded than less grain volume is needed (Deivasigamani and Swaminathan, 2018) [8]. Low test weights tend to result from poor grain fill and environmental conditions in the field before harvest. The 1000 grain weight is a very important measure of seed quality, which is effective on sprouting, seed potential, seedling growth, and plant performance (Afshari *et al*., 2011) [1]. This quality is dependent on the size of embryo and reserved nutrients quantity used for sprouting and growth (Ebadi and Hisoriev, 2011; Cao *et al*., 2011) [10, 5]. In our experiment, the test weight ranged from 1.27 to 4.19g in *kharif* 2018-19 and 1.85 to 3.57g in *kharif* 2019-20 whereas, the mean was 3.01 and 2.77g in both the seasons respectively (Table 02). In first experimental season, genotype GEC69 recorded maximum test weight of 4.19g; followed by GEC79 (3.97g), IC0477650 (3.90g), IC0477406 (3.86g), GEC400 (3.66g), IR-01 (3.52g), GEC371 (3.41g), IC0476378 (3.34g), GEC122 (3.33g), GEC352 (3.31g) and others. Among the check genotypes IR-01 recorded maximum grain yield of 3.52g followed by GPU28 (3.24g), CG Ragi 02 (2.88g) and GPU-67 (2.84g). In next season, *kharif* 2019-20 the maximum value was reduced to 3.57g (IC0477406) and similarly the average, as well, to 2.77g. Among other entries GPU 28 (3.56g), GEC400 (3.52g), GEC41 (3.34g), GEC79 (3.26g), GEC132 (3.21g), IR-01 (3.18g), GEC122 (3.12g), IC0476707 (3.07g) and GEC280 (3.02g) were exhibited comparative higher test weight for the season. As per expectation, check varieties did not show much variation i.e., GPU 28-3.56g; IR-01-3.18g; GPU 67-2.86g and CG-Ragi 02-2.81g; which indicated relative stability and adaptability. When pooled over environments, accessions IC0477406 (3.71g), GEC79 (3.61g), GEC400 (3.59g), IC0477650 (3.38g), GEC69 (3.31g), GEC122 (3.23g), GEC371 (3.18g), GEC132 (3.03g), GEC274 (3.021g) and IC0477317 (2.99g) were found overall good with respect to the trait. The test weight is used as grain quality and is measure of grain bulk density. This mainly depends upon size of embryo and reserve nutrient quantity. Earlier Conley and John (2013) [7] and Deivasigamani and Swaminathan (2018) [8] have stated the biological significance of this trait as; test weight is an important factor to consider varietal selection, since both environment and pests greatly affects test weight therefore, selecting a variety possessing high test weight potential is critical to maximise economic gain. However, it should be noted that test weight is an indicator of grain quality and effects yield directly but sometimes higher test weight reduces the total number of grains per unit plant area, which eventually reduces the final grain yield. So, selection should be done parallelly with ultimate breeding objective.

Grain weight comparison

Over the last two decades, area and production of finger millet are in declining phase due to the replacement of this crop by other competitive crops, so there is a need to increase its productivity. To achieve this, efforts have been made in realizing high yield potential using genetic resources across the world. Improved finger millet varieties have been developed mostly by selection or hybridization followed by selection (Gowda *et al*., 2015; Sogoba *et al*., 2020) [13, 27], but it is almost reaching stagnation. To achieve higher yield potential, release of maximum variability is essential, but in finger millet this release of variability is slow and arduous because of its polyploid nature and difficulty in hybridization. Therefore, prebreeding and exploration of plant genetic resource become essential which opens the old, but evenly promising, avenue of crop improvement. In first year of experiment, genotype IC0476838 recorded maximum grain yield (32.96q ha^{-1}) followed by GPU 67 (32.78q), IC0477406 (32.10q), GEC11 (28.62q), GEC122 (28.28q), IC0476378 (27.47q), IC0477650 (27.31q), IC0476663 (27.00q), GEC348 (26.49q) and GEC322 (26.04q) (Table 02; Fig. 01). In second year (*kharif* 2019-20). The range for grain yield was recorded between 15.43-37.42q ha^{-1}, and promising genotypes were GPU 67 (37.42q), IC0476838 (33.95q), IC0477591 (28.28q), IC0477406 (28.05q), IR-01 (27.96q), GEC122 (27.74q) and GPU28 (24.38q). When the data was pooled over environments and critical examination was done, among the check genotypes all four fragmented over the ranking, which justified the worth of keeping large number of checks. In next, criteria for yield comparison based on percent increase over best check could not work because best check ranked 1st. Further when statistical comparison was done, GPU67 was at first position numerically but (CD ≤ 7.396 q ha^{-1}) it was similar to IC0476838, IC0477406 and GEC122. Similarly other checks i.e., GPU 28 and IR-01 were statistically similar with GEC371, IC0476663, GEC348, IC0477591, GEC122 and IC0477406 at same of critical difference. Therefore, genotypes IC0476838, IC0477406, GEC122, GEC371, IC0476663, GEC348 and IC0477591 are concluded to be outcome of research and are suggested to evaluate in further varietal evaluation programme.

The study showed that the effect of environments, varieties, and their interactions for grain yield was significant and the environment played a significant role in influencing the expression of studied traits, which suggests the varied performance of the varieties across environments (Sayar *et al*., 2013; De-Leon *et al*., 2016; Falcon *et al*., 2019) [31, 30, 29]. This is indicative of the necessity of testing finger millet varieties at multiple locations for large-scale production. An ideal finger millet genotype should have a high mean yield combined with a low degree of fluctuation under different environments. The combined mean grain yield value of varieties over environments indicated that IC0476838 (33.46q ha^{-1}), IC0477406 (30.07q ha^{-1}), GEC122 (28.01q ha^{-1}), IC0477591 (26.70q ha^{-1}), GEC348 (24.88q ha^{-1}), IC0476663 (24.58q ha^{-1}) and GEC371 (24.54q ha^{-1}) had the highest grain yield performance. Hence, these varieties could be recommended for further pre-extension and demonstration in the study areas and area with similar agro-ecologies.

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Table 1: Biannual Mean performance of elite germplasm accessions and check varieties

Entry	Days to 50% flowering				Productive Tillers per plant				Fingers per Ear			
	2018-19	2019-20	Mean	SE	2018-19	2019-20	Mean	SE	2018-19	2019-20	Mean	SE
IC0476378	77	60	68.5	8.5	3	2	2.5	0.5	7.0	6.3	6.65	0.35
IC0477890	75	69	72.0	3.0	2	2	2.0	0.0	5.7	5.0	5.35	0.35
GEC371	74	64	69.0	5.0	2	1	1.5	0.5	5.7	6.3	6.00	0.30
IC0477650	77	70	73.5	3.5	3	3	3.0	0.0	5.7	7.3	6.50	0.80
GEC41	80	74	77.0	3.0	2	2	2.0	0.0	5.0	5.7	5.35	0.35
GEC322	85	88	86.5	1.5	1	1	1.0	0.0	5.3	4.3	4.80	0.50
GEC11	81	85	83.0	2.0	2	2	2.0	0.0	6.0	5.3	5.65	0.35
GEC69	83	80	81.5	1.5	3	2	2.5	0.5	6.3	6.0	6.15	0.15
IC0476707	67	72	69.5	2.5	2	1	1.5	0.5	5.0	5.0	5.00	0.00
GEC274	77	71	74.0	3.0	2	3	2.5	0.5	5.3	6.0	5.65	0.35
GEC400	71	78	74.5	3.5	2	1	1.5	0.5	5.0	6.7	5.85	0.85
GEC270	66	69	67.5	1.5	1	2	1.5	0.5	4.7	5.0	4.85	0.15
IC0476838	73	71	72.0	1.0	2	2	2.0	0.0	5.7	7.0	6.35	0.65
GEC132	56	58	57.0	1.0	2	2	2.0	0.0	4.7	5.7	5.20	0.50
GEC352	72	76	74.0	2.0	3	3	3.0	0.0	6.0	4.7	5.35	0.65
GEC106	74	74	74.0	0.0	2	3	2.5	0.5	5.0	5.3	5.15	0.15
GEC79	77	90	83.5	6.5	2	2	2.0	0.0	5.7	7.0	6.35	0.65
IC0477317	68	78	73.0	5.0	1	1	1.0	0.0	7.0	6.7	6.85	0.15
GEC137	72	71	71.5	0.5	2	3	2.5	0.5	6.3	7.7	7.00	0.70
GEC296	84	58	71.0	13.0	1	1	1.0	0.0	5.0	5.7	5.35	0.35
IC0477620	75	59	67.0	8.0	2	2	2.0	0.0	7.0	8.7	7.85	0.85
IC0476864	76	71	73.5	2.5	3	2	2.5	0.5	6.0	6.0	6.00	0.00
GEC280	85	63	74.0	11.0	3	3	3.0	0.0	5.3	6.7	6.00	0.70
IC0476663	72	70	71.0	1.0	2	3	2.5	0.5	7.3	6.7	7.00	0.30
GEC348	67	61	64.0	3.0	1	2	1.5	0.5	5.0	5.7	5.35	0.35
GEC122	88	95	91.5	3.5	2	1	1.5	0.5	6.7	9.0	7.85	1.15

IC0477591	76	56	66.0	10.0	2	3	2.5	0.5	5.7	5.3	5.50	0.20
IC0477406	61	80	70.5	9.5	2	2	2.0	0.0	7.3	6.3	6.80	0.50
GPU 28*	76	79	77.5	1.5	3	2	2.5	0.5	6.3	4.7	5.50	0.80
GPU 67*	84	86	85.0	1.0	3	3	3.0	0.0	6.0	5.7	5.85	0.15
CG-Ragi 02*	85	84	68.5	8.5	3	2	2.5	0.5	6.3	5.3	6.65	0.35
IR-01*	91	89	72.0	3.0	2	2	2.0	0.0	7.3	8.3	5.35	0.35

2018-19, 2019-20 = *kharif* 2018-19, 2019-20 respectively; SE – Standard error; DF = days to 50 percent flowering; T/p = tillers per plant; TW = test weight (g); GW = grain weight per plot (g); GW (q ha^{-1}) = grain weight per hectare (q).

Table 2: Biannual Mean performance of elite germplasm accessions and check varieties

Entry	Test weight (g)				Grain weight per plot (g)				Grain weight (q ha^{-1})			
	2018-19	2019-20	Mean	SE	2018-19	2019-20	Mean	SE	2018-19	2019-20	Mean	SE
IC0476378	3.34	2.21	2.78	0.57	1.48	0.85	1.17	0.32	27.47	15.80	21.64	5.84
IC0477890	3.05	2.32	2.69	0.37	1.12	1.23	1.18	0.06	20.77	22.84	21.81	1.04
GEC371	3.41	2.94	3.18	0.24	1.36	1.29	1.33	0.04	25.25	23.83	24.54	0.71
IC0477650	3.90	2.87	3.39	0.52	1.47	1.06	1.27	0.21	27.31	19.57	23.44	3.87
GEC41	1.27	3.34	2.31	1.04	0.75	1.04	0.90	0.15	13.81	19.26	16.54	2.73
GEC322	2.94	2.50	2.72	0.22	1.41	1.11	1.26	0.15	26.04	20.62	23.33	2.71
GEC11	2.59	1.85	2.22	0.37	1.55	0.94	1.25	0.31	28.62	17.35	22.99	5.64
GEC69	4.19	2.44	3.32	0.88	1.22	1.04	1.13	0.09	22.57	19.20	20.89	1.69
IC0476707	1.94	3.07	2.51	0.57	0.61	1.03	0.82	0.21	11.25	19.07	15.16	3.91
GEC274	3.15	2.86	3.01	0.15	1.23	1.24	1.24	0.01	22.81	23.02	22.92	0.11
GEC400	3.66	3.52	3.59	0.07	1.01	0.92	0.97	0.05	18.62	17.04	17.83	0.79
GEC270	3.09	2.68	2.89	0.21	0.88	1.06	0.97	0.09	16.35	19.63	17.99	1.64
IC0476838	2.68	2.32	2.50	0.18	1.33	0.97	1.15	0.18	24.60	17.94	21.27	3.33
GEC132	2.84	3.21	3.03	0.19	1.78	1.83	1.81	0.03	32.96	33.95	33.46	0.50
GEC352	3.31	2.43	2.87	0.44	1.11	1.51	1.31	0.20	20.63	27.96	24.30	3.67
GEC106	3.28	2.56	2.92	0.36	1.08	1.13	1.11	0.03	20.00	20.96	20.48	0.48
GEC79	3.97	3.26	3.62	0.36	0.69	0.88	0.79	0.10	12.86	16.25	14.56	1.70
IC0477317	3.25	2.73	2.99	0.26	0.79	0.83	0.81	0.02	14.68	15.43	15.06	0.38
GEC137	3.15	2.65	2.90	0.25	0.83	1.14	0.99	0.16	15.31	21.19	18.25	2.94
GEC296	2.60	1.97	2.29	0.32	1.22	0.98	1.10	0.12	22.63	18.23	20.43	2.20
IC0477620	2.01	2.17	2.09	0.08	0.85	1.14	1.00	0.15	15.68	21.15	18.42	2.74
IC0476864	3.27	2.10	2.69	0.59	0.54	0.91	0.73	0.19	9.96	16.84	13.40	3.44
GEC280	2.66	3.02	2.84	0.18	1.12	1.10	1.11	0.01	20.78	20.38	20.58	0.20
IC0476663	2.54	2.92	2.73	0.19	1.18	1.19	1.19	0.01	21.78	22.11	21.95	0.17
GEC348	2.31	2.57	2.44	0.13	0.97	1.13	1.05	0.08	17.96	20.93	19.45	1.49
GEC122	3.33	3.12	3.23	0.11	1.46	1.20	1.33	0.13	27.00	22.16	24.58	2.42
IC0477591	2.36	2.98	2.67	0.31	1.43	1.26	1.35	0.09	26.49	23.27	24.88	1.61
IC0477406	3.86	3.57	3.72	0.15	1.53	1.50	1.52	0.02	28.28	27.74	28.01	0.27
GPU 28*	3.24	3.56	3.40	0.16	1.36	1.53	1.45	0.09	25.12	28.28	26.70	1.58
GPU 67*	2.84	2.86	2.85	0.01	1.73	1.51	1.62	0.11	32.10	28.05	30.08	2.03
CG-Ragi 02*	2.88	2.81	2.78	0.57	1.32	1.32	1.17	0.32	24.44	24.38	21.64	5.84
IR-01*	3.52	3.18	2.69	0.37	1.77	2.02	1.18	0.06	32.78	37.42	21.81	1.04

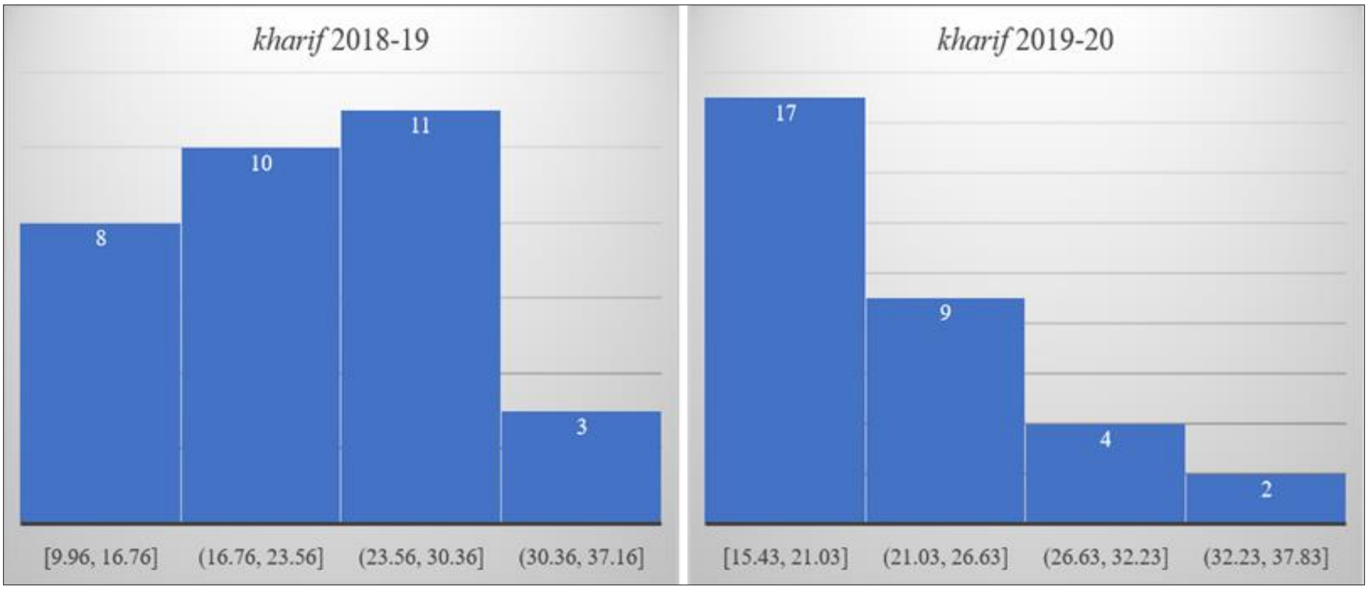

Fig 1: Histogram of grain yield distribution over the years

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