

Original Research Article

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## Grouping of Landraces Based on Seed, Seedling and Plant Morphological Traits in *rabi* Sorghum [*Sorghum bicolor* (L.) Moench]

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### ABSTRACT

The field experiment was carried out during *rabi* season 2016-17 at Regional Agricultural Research Station, College of Agriculture, Vijayapur. The experimental material was comprised of 94 diverse *rabi* sorghum landraces. These landraces of *rabi* sorghum collected from AICRP on sorghum, Regional Agricultural Research Station, Vijayapur and Farmers, were used for study the grouping of landraces based on seed, seedling and plant morphological traits. The results of the investigation indicated that among the ninety four landraces fifty four were yellow white caryopsis, fifty one were elliptic grain shape, sixty two were non-lustrous grain type and landraces varied with respect to seed length, seed width, seed area. The landraces were also tested for the seed quality parameter and showed high seed germination, short shoot length, medium root length, low seedling vigour index, forty five landraces showed heavy test weight. Sixty four landraces showed medium plant height, all landraces showed late flowering, more number of landraces showed long leaf length, leaf breadth, medium green leaf color, drooping type leaf orientation, thirty eight landraces were symmetric type panicle shape, thirty three were semi loose earhead, sixty one landraces showed short panicle length, fifty four were grayed orange glume color, sixty landraces showed medium glume: length.

#### Keywords

Grouping,  
Sorghum,  
Landraces, *Rabi*  
season

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### Introduction

Sorghum is one of the main staples for the world's poorest and most food-insecure people. The crop is genetically suited to hot and dry agro ecologies where it is difficult to grow other food grains.

These are also areas subject to frequent drought. In many of these agro ecologies, sorghum is truly a dual-purpose crop; both grain and Stover are highly valued outputs. In large parts of the developing world, Stover

represents up to 50 percent of the total value of the crop, especially in drought years.

In India, the crop is known as “jola” in Kannada, “jowar” in Hindi, “cholam” in Tamil which indicates the variability of Indian culture. Sorghum ranks third in the major food grain crops of our country. It is grown on 40 million ha in 105 countries of Africa, Asia, Oceania and America. India account for the largest share (>70 %) of global sorghum area, while USA, Mexico, Nigeria, Sudan and India are the major sorghum producers (USDA,

2017). In India, sorghum is cultivated over an area of 5.62 million ha with an annual production of 4.56 million tonnes of grain with a productivity of 812 kg/ha. The first three largest producing states are Maharashtra, Karnataka and Madhya Pradesh (Anonymous, 2017). In Karnataka, it is cultivated in 0.94 million ha with an annual production of 0.84 million tonnes of grain with a productivity of 892 kg/ha (Anonymous, 2017). It is generally cultivated in both the *kharif* (rainy) and *rabi* (post-rainy) seasons.

Landraces or farmer varieties constitute the basic material for developing any variety or hybrid. Landraces are the varieties nurtured and cultivated by the farmers through traditional method of selection over the decades. Landrace is a variety with a high capacity to tolerate biotic and abiotic stress, resulting in high yield stability and an intermediate yield level under a low input agricultural system (Zeven, 1998). The Biodiversity Act (2002) describes “landrace” as primitive cultivar that was grown by ancient farmers and their successors. The variability existed in collected landraces will be utilized for different research activities in sorghum improvement programs for increasing production and productivity of the crop. And since the region has a high agricultural potential, productivity for better food security could be improved by use of locally available landraces adapted to this particular environment. Hence an attempt has been made Grouping of landraces based on seed, seedling and plant morphological traits in *rabi* sorghum.

### **Materials and Methods**

The field experiment was carried out during *rabi* season 2016-17 at Regional Agricultural Research Station, College of Agriculture, Vijayapur and laboratory studies in Seed Science and Technology department, College

of Agriculture, Vijayapur (Karnataka). The experimental material consisting of 94 diverse *rabi* sorghum landraces. These landraces of *rabi* Sorghum were collected from AICRP on sorghum, Regional Agricultural Research Station, Vijayapur and Farmers. The 94 *rabi* sorghum landraces were sown during *rabi* 2017 in a single row of four meter length with a spacing of 45 cm between rows and 15 cm between plants. The experiment was laid out in randomized block design with three replications. The crop was raised by following all the agronomical practices recommended for *rabi* sorghum as per the packages of practices for high yields published by University of Agricultural Sciences, Dharwad. The observations were recorded on seed, seedling and plant morphological traits based on the results of experiment and grouping of *rabi* sorghum landraces were made as per the DUS and PPV&FR guidelines.

### **Results and Discussion**

Results of the investigation are present in the following sub heads.

#### **Seed morphological characters**

In the present study caryopsis also varied among *rabi* sorghum landraces when compared with Munsell chart which showed two groups viz., grayed white, and yellow white. Among the ninety four landraces fifty four landraces has yellow white caryopsis and it is influenced by environmental conditions during ripening, after ripening, besides the genetic effect (Pascaul *et al.*, 1993). Seed shape has also been used by several workers for characterization of several genotypes (Shaista Halim and Saxena, 1995, Thangavel *et al.*, 2005, Sangawan *et al.*, 2005; Reddy *et al.*, 2007). All the tested landraces in the present study have showed circular shape and elliptic in both dorsal and profile view. Among the 94 *rabi* sorghum landraces, forty

three were circular, fifty one were elliptic grain shape. Seed lustre has also been used by several workers for characterization of sweet sorghum genotypes (Thangavel *et al.*, 2005, Reddy *et al.*, 2007). Among the 94 *rabi* sorghum landraces, thirty two were Lustrous, sixty two were Non-lustrous grain.

The seed length, width and seed area also important traits used to grouping the *rabi* sorghum landraces because seeds vary greatly in their size and this mainly depends on its dimensions so seed can be classified as either bold or small which can be observed very easily. Based on the seed length, the *rabi* sorghum landraces were grouped into three categories as short (<0.3 mm), medium (0.3-0.6 mm) and long seed length (>0.6 mm). Among the 94 *rabi* sorghum landraces, twenty three were short, fifty six were medium, and fifteen landraces were long in seed length. Based on the seed width, the landraces were grouped into three categories as short, less than 0.3 mm, medium 0.3-0.6 mm and long with seed width more than 0.6 mm. Among the 94 *rabi* sorghum landraces, eighteen were short, sixty five were medium, and eleven landraces were long in seed width (Figure 1). Similar classification were used by several workers for the characterization and identification of crop varieties viz., Paramesh (1983) in soybean; Vijayageetha (2007) in mustard. Test weight is one of the distinguishing features used by several scientists to differentiate several crop varieties. Based on thousand seed weight, the landraces were grouped into three categories as small sized with the thousand seed weight less than 20.00 g, medium sized with the thousand seed weight 20-30 g and bold sized with the thousand seed weight more than 30.00 g. Among the 94 *rabi* sorghum landraces, Ten landraces were grouped into light, thirty nine landraces grouped into medium and forty five grouped as heavy. The variation in test weight is due to their genetic

makeup. Such variations in test weight were also noticed in several crops like pearl millet (Shaista Halim and Saxena, 1995) and forage sorghum (Sangawan *et al.*, 2005).

### **Seedling morphological character**

Morphological traits of seedling were found to be useful only for broader classification of landraces into different groups, but not for identification of individual landrace. For varietal characterization, their utility appears to be doubtful as these characters are quantifiable in nature and are subjected to environmental fluctuation (Greb, 1957). Expression of different characteristics of seedlings like anthocyanin pigmentation is found to be varietal specific and helps in early identification of *rabi* sorghum landraces at seedling stage itself and there by saves time. The results of present investigation revealed that, seedling morphological characters were used to characterize *rabi* sorghum landraces. Based on presence and absence of anthocyanin pigmentation, landraces were characterized into two groups. In more landraces anthocyanin pigmentation was present.

The seed germination percentage varied among the landraces due to the quality parameters and could be attributed to better development of seeds. Based on the germination percentage, the landraces were grouped into three groups as less germination (<75.00 %), medium germination (75.00 %-85.00 %) and high germination (>85.00 %) percentage. Among the 94 *rabi* sorghum landraces, twenty seven landraces were less, thirty three landraces were medium whereas thirty four landraces were high in germination per cent. Thus, these characters were taken in characterizing the landraces. Based on the shoot length and root length the sorghum landraces were grouped into three categories as short, medium and long. Among the 94 *rabi* sorghum landraces, thirty seven landraces

were falls under short category, thirty two landraces were medium and twenty five landraces were long Shoot length. Among the 94 rabi sorghum landraces, twenty nine were short, fifty four landraces were medium, while twelve landraces were long root length (Figure 2). The variation in seedling length was due to its better quality of seeds of genotypes. The seedling length was found to be an important characteristic in the black gram varietal identification as reported by Chakrabarthy and Agarwal (1989). Based on the seedling vigour index the landraces were grouped into three groups as low vigour (< 2,500.00), medium vigour (2500.01-3000.00) and high vigour (> 3,001.00) landraces. Among the 94 rabi sorghum landraces, sixty one landraces were low vigour index, twenty nine landraces were medium and only four landraces were high vigour index.

### **Plant morphological characters**

This is traditional method of varietal identification in which plants have to be maintained till maturity. In the present study, several plant morphological characters were studied for grouping of different rabi sorghum landraces and are discussed below:

Based on plant height, the landraces were grouped into five categories as very short (< 76 cm), short (76-150 cm), medium (151-225 cm), Tall (226-300 cm), very Tall (> 300 cm). Among the 94 rabi sorghum landraces twenty one landraces are dwarf, sixty four are medium plant height and only nine landraces are tall in plant height (Figure 3). Based on days to 50 percent flowering landraces were grouped in to three categories as early (<38.00 days), medium (38.00-40.00 days) and late (>40.00 days). Among the 94 rabi sorghum landraces all the landraces took more than 45 days to 50 % flowering. Similar difference in days to 50 per cent flowering was also noticed by Palanisamy and Subramanian (1986) and

Reddy *et al.*, (2007) in sorghum. Based on the leaf length the landraces were grouped into short (<55 cm), medium (55-60 cm) and long (>60 cm). Among the 94 rabi sorghum landraces thirteen were short, twenty six landraces were medium and fifty five were long leaf length. Based on leaf breadth the landraces were grouped into short (< 6.00 cm), medium (6.00-7.00 cm) and long (> 7.00 cm). Among the 94 rabi sorghum landraces sixteen landraces were short in leaf breadth, twenty two landraces were medium in leaf breadth and fifty six landraces were long in leaf breadth (Figure 6). Among the 94 rabi sorghum landraces thirty six were medium green leaf, twenty eight were showed light green, and thirty landraces were showed dark green leaf. These characters may be influenced by environmental factors, nutritional status and also due to genetic effect. These traits are also studied and found diverse by Pahuja *et al.*, (2002). Based on the panicle density, the landraces were grouped into very loose, loose, semiloose, compact and semi compact. Most of the panicles are loose, semi loose and compact type (Figure 5). This character can also be used to identifying the landraces. Similar type of panicle density grouping was used by Sangawan *et al.*, (2005) in forage sorghum. Based on length of panicle, sorghum landraces were grouped into very short (<11 cm), short (11-20 cm), medium (21-30 cm), long (31-40 cm), very long (>40 cm). Among the 94 rabi sorghum landraces, thirty two were very short in panicle length; sixty one were short in panicle length and whereas one landrace was long in panicle length. These characters may be influenced by environmental factors, nutritional status and also due to genetic effect. Hence, this trait also used for varietal characterization. Similar observations were also made by, Gopal Reddy *et al.*, (2006) in foxtail millet, Audilakshmi *et al.*, (2004), Reddy *et al.*, (2007) in sorghum hybrids and Sandeep (2007) in sweet sorghum.

**Fig.1** Grouping of *rabi* sorghum landraces based on seed morphological character

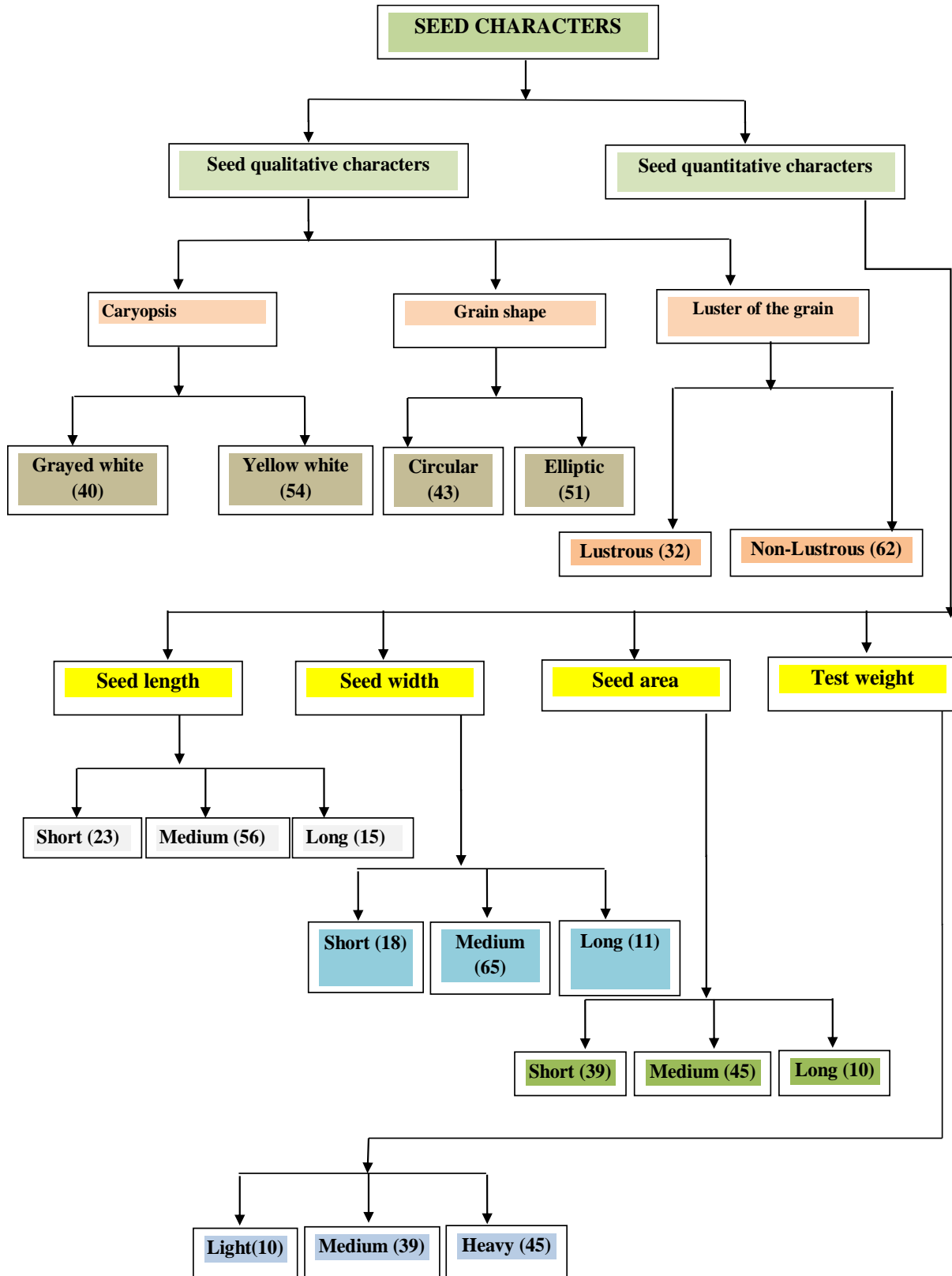


Fig.2 Grouping of *rabi* sorghum landraces based on seedling morphological character

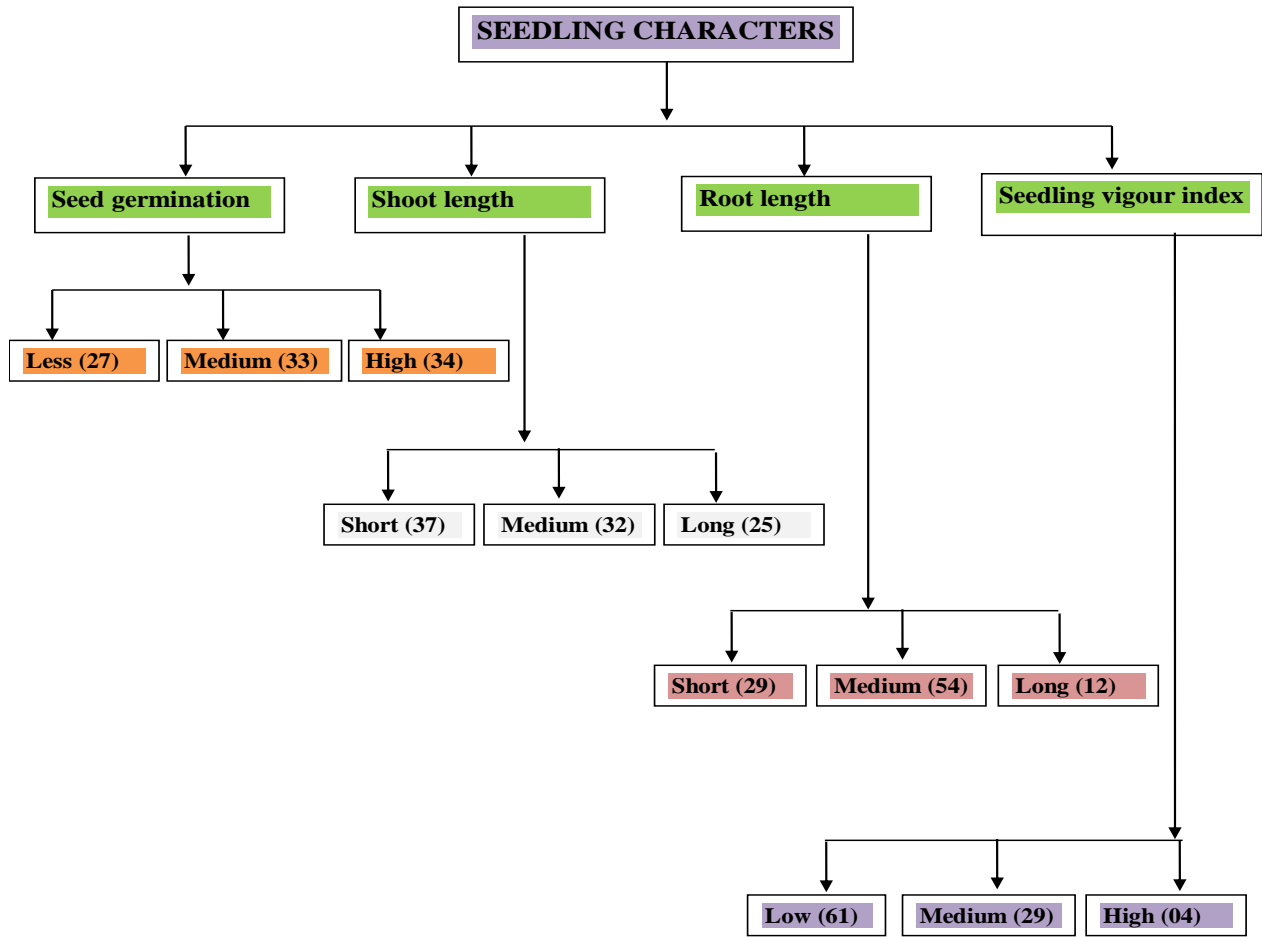
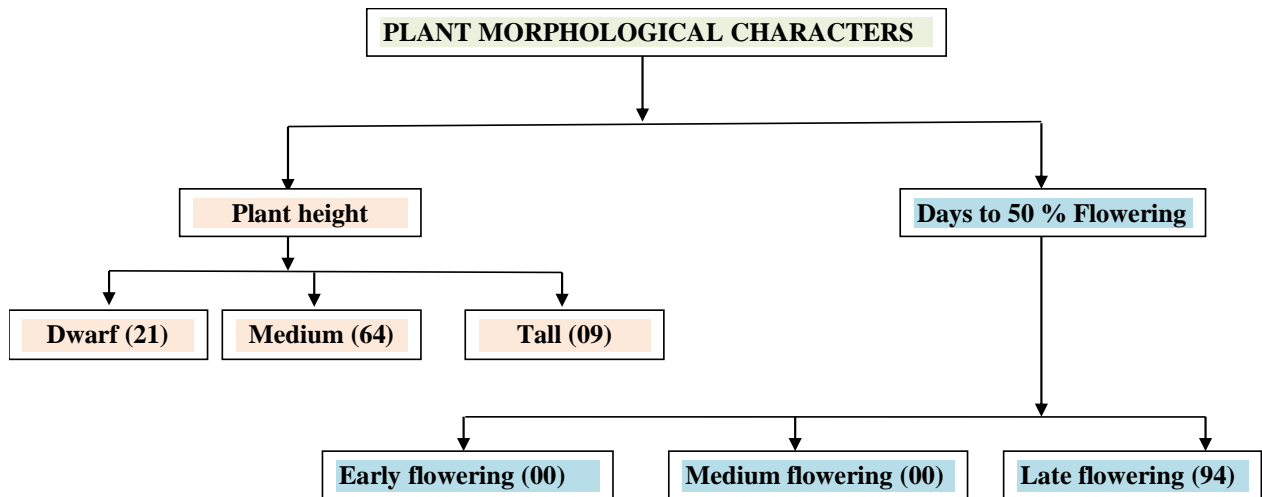
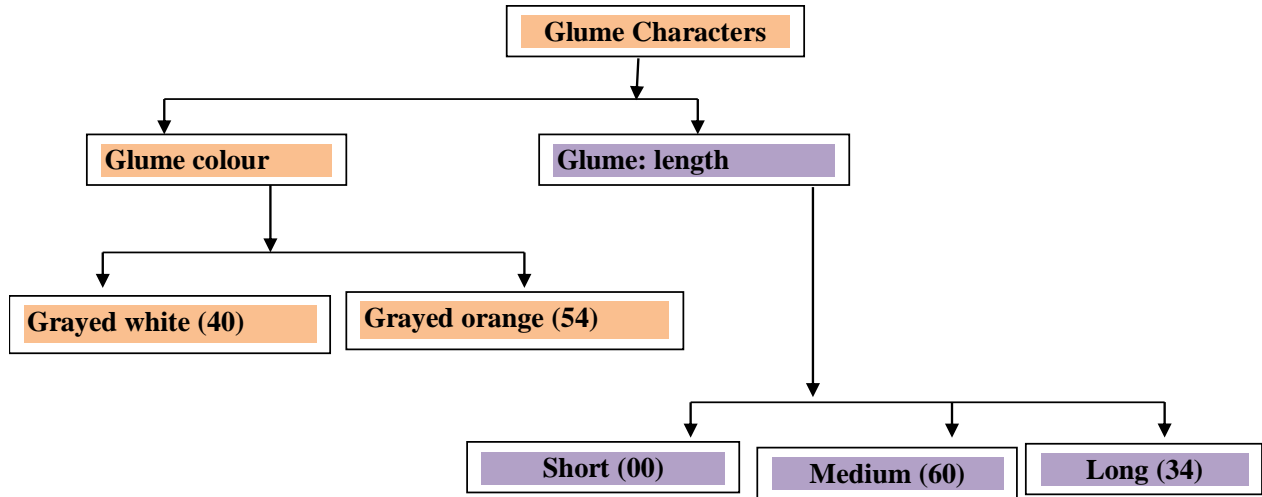


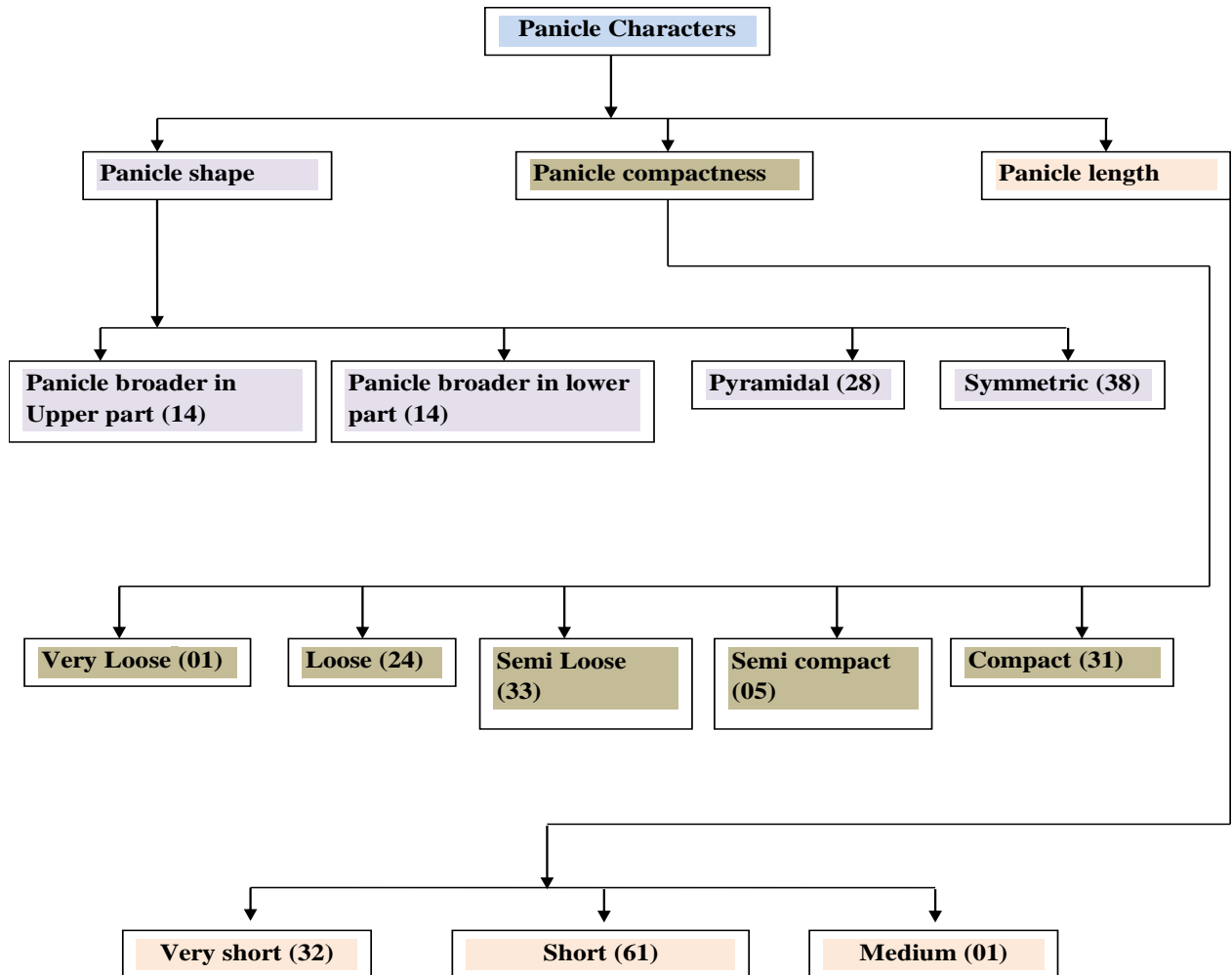
Fig.3 Grouping of *rabi* sorghum landraces based on plant morphological character and days TO 50 % flowering



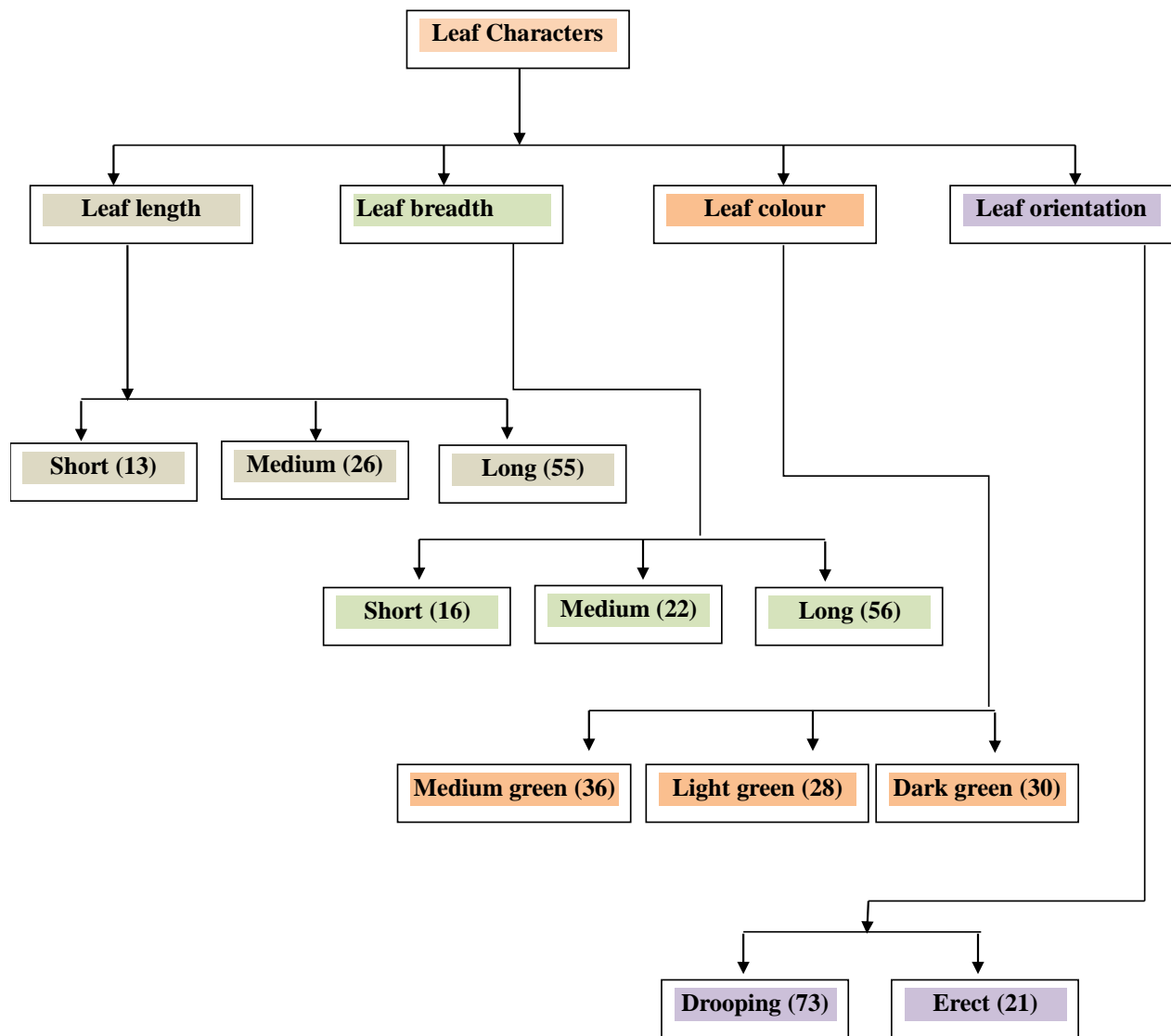
**Fig.4** Grouping of *rabi* sorghum landraces based on glume characters



**Fig.5** Grouping of *rabi* sorghum landraces based on panicle characters



**Fig.6** Grouping of *rabi* sorghum landraces based on leaf character



Glume, panicle shape, and glume length can be also utilized to grouping the landraces. These characters may be influenced by environmental factors, nutritional status and also due to genetic effect.

Based on glume landraces were grouped into green white, yellow white, grayed orange, grayed red, grayed purple (Figure 4). Among the 94 *rabi* sorghum landraces, the forty landraces are grayed white, and fifty four landraces showed grayed orange glume. Based

on the coverage of grain by glume the *rabi* sorghum landraces were grouped into 100 % coverage, 75 % coverage, 50 % coverage. Among the 94 *rabi* sorghum landraces there were no landraces where 50 % grain is covered by glume and sixty landraces were grouped under the grain covered 75 % by the glume and thirty four landraces were grouped under the grain covered by 100 % by the glume. These traits are also studied and found diverse by Pahuja *et al.*, (2002), Umakanth *et al.*,(2002), Sangwan *et al.*, (2005), Elangovan *et al.*,



(2006), Nabi *et al.*, (2006), Reddy *et al.*, (2009) and Missihoun *et al.*, (2015).

In the present study the seed morphological characters like caryopsis, seed shape, seed lustre, test weight, seed length, seed width and seed area were studied and the *rabi* sorghum landraces were grouped as per the individual behavior of landraces with these characters. The landraces showed grayed white and yellow white caryopsis. All the tested landraces in the present study have showed circular shape and elliptic seed shape in both dorsal and profile view. Based on seed lustre sorghum landraces were grouped into lustre and non lustre, majority were non lustrous. Based on test weight, landraces were grouped into three categories viz., light, medium and heavy. Most of the landraces were either medium or heavy. The seed length, seed width and seed area also important traits used to group the sorghum landraces because seeds vary greatly in their size and this mainly depends on its dimensions so seed can be classified as either bold or small which can be observed very easily.

The shoot length, root length, seedling length, seedling pigmentation and seed germination varied among the landraces. Based on the variation in the shoot, root and seedling length the landraces were grouped as short length, medium length and long length. While pigmentation as present or absent, whereas seed germination percentage helped to differentiate the landraces in three groups as less germination, medium germination and high germination categories.

The plant morphological characters like plant height, days to 50 per cent flowering, leaf length, leaf breadth, of leaf, Leaf orientation, midrib coloration, panicle length, panicle density, glume length, glume, varied among the *rabi* sorghum landraces. Based on plant height, the landraces were grouped into five categories as very short, short, medium, tall, very tall. Based on days to 50 percent flowering landraces were grouped in to three categories as early (<38.00 days), medium (38.00-40.00

days) and late (>40.00 days). Based on the leaf length and Leaf breadth the landraces were grouped into short, medium and long. The landraces were categorized into very loose, loose, semi loose, compact and semi compact based on the panicle density at maturity. Among the ninety four landraces Navalgunda local A-1-2 had very loose panicle density. Based on panicle shape, *rabi* sorghum landraces were grouped into panicle broader in lower part, panicle broader in upper part, pyramidal and symmetric shape. This character also helps in grouping of landraces. Based on the glume the landraces were grouped into grayed white and grayed orange. Majority among the landraces showed grayed orange glume. This character could be used for distinguishing from other landraces. Similarly based on the glume length, the *rabi* sorghum landraces were grouped into short, medium or long. Whereas, landrace ARS Annigeri A-1 has attained flowering late. Finally it may be concluded that the variability existed in collected landraces will be utilized for different research activities in sorghum improvement programs for increasing production and productivity of the crop under rain fed situation.

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