Sorghum K 12(TKSV 0809) - A high yielding dual purpose sorghum variety for southern district of Tamil Nadu

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Abstract

Sorghum K 12 (TKSV 0809) is a high yielding dual-purpose sorghum variety identified for winter rainfed vertisol tracts of southern districts of Tamil Nadu. TKSV 0809 is a hybrid derivative of the cross SPV 772 x S 35-29 and evolved with an objective of development of high yielding dual-purpose short duration sorghum variety suitable for winter rainfed vertisol tracts of Tamil Nadu. TKSV 0809 was released as Sorghum K 12 variety to replace the existing variety K 8 during 2015 from Agricultural Research Station, Kovilpatti. K 12 sorghum is a short duration variety which matures in 95-100 days. K 12 sorghum is a photo insensitive variety suitable for growing in all seasons of Tamil Nadu against the ruling variety K8 which is photosensitive and suitable for Kharif season only. It recorded an average grain yield of 3123 kg/ha under the rainfed condition which is 22.4 and 23.9 per cent increased over the check K 8 and CSV 17 respectively. The K 12 Sorghum exhibited a potential grain yield of 5801 kg/ha under summer irrigated condition which is 139.3 per cent increased yield over check variety K 8.  K 12 sorghum (TKSV 0809) is a dual-purpose variety with an average dry fodder yield of 11.9 tonnes /ha. The dry fodder yield was 31.8% increased yield over local check K 8 and 40.7% over zonal check CSV 17. The grains are creamy white in colour and suitable for cooking, popping, flaking and other value-added products. It is moderately resistant to shoot fly, stem borer and resistant to downy mildew.

Keywords

Sorghum (K 12), high yielding, grain and fodder.

INTRODUCTION

Sorghum (Sorghum bicolor (L)) is the fourth important food crop in India, best-suited cereal crop for semi-arid environments. It is substantially popular among the farmers due to its greater adaptability and various forms of utility as grain, green fodder, Stover and silage. It is an important staple food grain after rice and wheat for millions of poor and most important food for insecure people in the semiarid tropics of India. Sorghum also offers great potential to supplement the fodder requirement of the growing dairy industry in India.

In Tamil Nadu, sorghum is grown in an area of 3.47 lakh hectares. Sorghum is a dual-purpose crop where both grain and fodder are highly valued outputs. It is therefore of paramount importance that technological developments are extended to increase the productivity and sustainability of sorghum production in rainfed vertisol tracts. Sorghum K tall (hybrid) and K 8 are the Rabi sorghum specially adapted to the vertisol tracts of the southern region. The hybrid K tall is an early, high yielding dual-purpose hybrid but highly susceptible to lodging cause considerable fodder loss. Sorghum K 8 is a grain sorghum variety, meant for high-quality grains, but not suitable for fodder. Moreover it is suitable for Kharif season only due to photo sensitiveness. Under these circumstances, it is necessary to develop a short duration, dual-purpose photo- insensitive variety with high yield potential than K 8 sorghum for the rainfed vertisol tract. Breeding work had been initiated at Agricultural Research Station, Kovilpatti from 2008 to achieve the above...
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objective. Finally, it resulted in the development of a high yielding dual-purpose, photo insensitive sorghum culture TKSV 0809 (K 12) for rainfed vertisol tracts of southern districts of Tamil Nadu.

MATERIALS AND METHODS
Breeding work was initiated with F$_2$ segregating material received from the off-season nursery materials of AIC SIP programme to evolve high yielding drought-tolerant sorghum variety. The F$_2$ segregating progenies of the cross involving high yielding line SPV 22 (female parent) with S 35-29 (male parent) was taken for the evolution of drought-tolerant variety. As an outcome of a superior segregant was identified as high yielding drought-tolerant dual-purpose line TKSV 0809 suitable for the rainfed vertisol tracts. The culture TKSV 0809 was tested in various yield trials viz., Replicated Row Yield Trial, Preliminary Yield Trial and Advanced Yield Trial at ARS, Kovilpatti from 2007-2012 along with local checks K 8, CoS 28 and Co 30. In multi-location trial, TKSV 0809 was tested at various research stations of Tamil Nadu Agricultural University from 2009 to 12. The Adaptive Research trials were conducted in the farmer’s fields of winter rainfed tracts during 2011-12 and 2012-13.

TKSV 0809 was also evaluated in the All India Coordinated Sorghum Improvement Project during 2010-2011 as SPV 2084 along with the national check CSV 17. The screening was done against important pests from Kharif 2010-2013 and for diseases during Kharif 2013. The grain and Stover samples were also analyzed for their quality by following standard methods.

RESULTS AND DISCUSSION
The culture TKSV 0809 was tested at ARS, Kovilpatti in various yield trials from 2007 to 2012 under rainfed condition, revealed that TKSV 0809 had a consistent performance with mean grain yield of 3570 kg/ha against

| DUS characteristics of the Sorghum K 12 | Sorghum K 12 (TKSV 0809) |
|------------------------------------------|--------------------------|
| S. No. | Plant part | Characters | Sorghum K 12 |
|-------|------------|------------|--------------|
| 1.    | Seedling   | Anthocyanin colour of the coleoptiles | Green |
| 2.    | Leaf-sheath| Anthocyanin colouration | Tan |
| 3.    | Leaf       | Midrib colour of the 5th leaf | Dull white |
| 4.    | Plant      | Time of panicle emergence | Early (55 days) |
| 5.    | Plant      | Total height (at Maturity) | High (225-240 cm) |
| 6.    | Flag leaf  | Yellow colouration of the midrib | Absent |
| 7.    | Flag leaf  | Extension of discolouration of the midrib | Medium |
| 8.    | Glume      | Anthocyanin colouration of the pubescence | Absent |
| 9.    | Lemma      | Arista formation | Absent |
| 10.   | Stigma     | Anthocyanin | Absent |
| 11.   | Stigma     | Yellow colouration | Absent |
| 12.   | Stigma     | Length | Medium |
| 13.   | Flower with Pedicel | Length of the flower | Medium |
| 14.   | Anther     | Colour of the dry anther | Orange |
| 15.   | Anther     | Length (at flowering) | Medium |
| 16.   | Stem       | Stem diameter (at maturity) | Medium (1.8 to 2.6 cm) |
| 17.   | Stem       | Stalk juiciness | Juicy |
| 18.   | Stem       | Stalk sweetness | Sugary |
| 19.   | Leaf       | Length of the blade (3rd leaf from top) | Long (76 to 82 cm) |
| 20.   | Leaf       | Width of the blade (3rd leaf from top) | Narrow (6.5 to 8.0 cm) |
| 21.   | Peduncle   | Exertion | Exertion 10.0 to 15.0 cm |
| 22.   | Panicle    | Length | Medium (25 to 30 cm) |
| 23.   | Panicle    | Length of the branches (middle panicle) | Long (8.0 to 10.0 cm) |
| 24.   | Panicle    | Density at maturity | Semi compact |
| 25.   | Panicle    | Shape | Elongate |
| 26.   | Panicle    | Length of the neck visible above sheath | Medium (8.0 to 12.0 cm) |
| 27.   | Glume      | The colour at Physiological Maturity | Straw |
| 28.   | Glume      | Length | Medium (40% of Grain) |
| 29.   | Grain      | Caryopsis colour after threshing | Creamy White |
| 30.   | Grain      | 1000-grain weight | Medium (28.8 g) |
| 31.   | Grain      | Shape in dorsal view | Spherical |
| 32.   | Grain      | Shape in profile view | Spherical |
| 33.   | Grain      | Texture of endosperm | Half vitreous |
| 34.   | Grain      | Luster | Lustrous |
| 35.   | Duration   | Day to Flowering | 60 days (early) |
| 36.   | Duration   | Day to Maturity | 95 days (early) |
| 37.   | Yield      | Single plant seed yield (g/plant) | 40 g |
| 38.   | Yield      | Dry fodder yield (g/plant) | 102 g |
2827 and 2234 kg/ha by the checks K 8 and CSV 17 respectively. The grain yield was 23.2 and 59.8 per cent increased over the check variety K 8 and CSV 17 respectively. Mean dry fodder yield of TKSV 0809 was 13.92 t/ha as against 10.12 and 7.81 t/ha which was 37.5 and 78.2 per cent increased fodder yield over the checks K 8 and CSV 17 respectively.

The Multi-location trial was conducted at 30 locations over different seasons and years (16 locations in Kharif season over 3 years (2009-12), 9 locations in Rabi season over three years (2009-12) and 5 locations in summer season during 2010 under rainfed vertisol tracts of Tamil Nadu. TKSV 0809 recorded an average grain yield of 2886 kg/ha which was 14.1 and 14.5 per cent increased yield over the checks K 8 and CSV 17 respectively. TKSV 0809 also recorded higher dry fodder yield of 11.32 t/ha which is 48% increase over K 8 (7.65 t/ha) and 78.8% over CSV 17 (6.33 t/ha).

In All India Co-ordinated Sorghum Improvement Project trial TKSV 0809 was evaluated in three locations at the national level in the name of SPV 2084 during late Kharif and Rabi (2010-11). The culture TKSV 0809 has recorded an average grain yield of 4037 kg/ha which was 37.8 per cent increased yield over the national check CSV 17. It also registered high dry fodder yield of 4.27 t/ha which was 25.3 per cent increased yield over the national check CSV 17 (Table 1).

Table 1. Performance of sorghum culture TKSV 0809 in AICSIP trials late Kharif (2010 - 11)

| Sl. No. | Name of the district | No. of Location | Grain yield (kg/ha) | Dry fodder yield t/ha |
|--------|----------------------|-----------------|---------------------|----------------------|
|        |                      |                 | TKSV 0809 | K 8 (c) | CSV 17 (c) | TKSV 0809 | K 8 (c) | CSV 17 (c) |
| 1.     | Thoothukudi           | 10              | 2748       | 2582     | 2584       | 11.38     | 9.94     | 10.12     |
| 2.     | Ramanathapuram       | 8               | 2721       | 2332     | 2230       | -         | -        | -         |
| 3.     | Virudhunagar          | 5               | 2852       | 2821     | 2720       | 11.0      | 9.0      | 7.0       |
| 4.     | Tirunelveli           | 10              | 3616       | 3269     | 3382       | -         | -        | -         |
| 5.     | Sivagangai           | 10              | 2921       | 2415     | 2602       | -         | -        | -         |
| 6.     | Madurai              | 9               | 3156       | 2587     | 2437       | 7.84      | 7.35     | 7.27      |
| 7.     | Pudukottai           | 7               | 3864       | 3773     | 3784       | -         | -        | -         |
| 8.     | Dindigul             | 10              | 3324       | 2850     | 2391       | 10.0      | 8.0      | 7.0       |
| 9.     | Theni                | 10              | 3014       | 2304     | 2226       | 12.3      | 6.5      | 9.5       |
| Overall mean |                          | 79              | 3091       | 2801     | 2680       | 10.7      | 8.2      | 8.4       |
| % Increase over K 8(c) | | | 10.4 | - | - | 30.5 | - | - |
| % Increase over CSV 17(c) | | | 15.3 | - | - | 27.4 | - | - |

In Adaptive Research Trials (ART) conducted at 79 location during Rabi 2011-12 revealed that the sorghum culture TKSV 0809 recorded 3091 kg/ha which is 10.4 % increased yield over K 8 (2801 kg/ha) (Table 2). Similarly, in OFT (Rabi 2012-13) conducted in 58 locations this culture registered superior grain yield of 2743 kg/ha which is 22.7% increased yield over the best check K 8 (3138 kg/ha).

Table 2. Performance of sorghum culture TKSV 0809 in adaptive research trial (2011-12)

| Sl. No. | Name of the district | No. of Location | Grain yield (kg/ha) | Dry fodder yield t/ha |
|--------|----------------------|-----------------|---------------------|----------------------|
| 1.     | Thoothukudi           | 10              | 2748       | 2582     | 2584       | 11.38     | 9.94     | 10.12     |
| 2.     | Ramanathapuram       | 8               | 2721       | 2332     | 2230       | -         | -        | -         |
| 3.     | Virudhunagar          | 5               | 2852       | 2821     | 2720       | 11.0      | 9.0      | 7.0       |
| 4.     | Tirunelveli           | 10              | 3616       | 3269     | 3382       | -         | -        | -         |
| 5.     | Sivagangai           | 10              | 2921       | 2415     | 2602       | -         | -        | -         |
| 6.     | Madurai              | 9               | 3156       | 2587     | 2437       | 7.84      | 7.35     | 7.27      |
| 7.     | Pudukottai           | 7               | 3864       | 3773     | 3784       | -         | -        | -         |
| 8.     | Dindigul             | 10              | 3324       | 2850     | 2391       | 10.0      | 8.0      | 7.0       |
| 9.     | Theni                | 10              | 3014       | 2304     | 2226       | 12.3      | 6.5      | 9.5       |
| Overall mean |                          | 79              | 3091       | 2801     | 2680       | 10.7      | 8.2      | 8.4       |
| % Increase over K 8(c) | | | 10.4 | - | - | 30.5 | - | - |
| % Increase over CSV 17(c) | | | 15.3 | - | - | 27.4 | - | - |

Overall performance and its adaptability to different agro-climatic regions of the state are the basic criteria for release of any variety in a state. The culture TKSV 0809 recorded the average grain yield of 3123 kg/ha over 185 locations from different yield trials viz., Station trials, Multi-location trials, ART/ OFT and All India Co-ordinated trials. The yield increase of grain yield for TKSV 0809 (3123 kg/ha) is 22.4 and 23.9 per cent over the checks K 8 (2569 kg/ha) and CSV 17 (2579 kg/ha) respectively (Table 3). This culture registered maximum grain yield potential of 6519 kg/ha in the summer irrigated condition at Ayikudi, Tenkasi region as compared to the check K 8 (2296 kg/ha), which is 183.9 per cent increased yield over the check K 8.
Table 3. Overall Mean performance of TKSV 0809 culture for grain yield under different yield trials

| Sl. No. | Trials                        | No. of trials | Mean grain yield kg/ha | % increase over check |
|--------|-------------------------------|---------------|------------------------|-----------------------|
|        | TKSV 0809                     |               | K 8 (c)                | CSV 17 (c)            | K 8 (c) | CSV 17 (c) |
| 1.     | Station trials                | 5             | 3570                   | 2897                  | 2234    | 23.2     | 59.8     |
| 2.     | Multi-location trials         | 30            | 2886                   | 2530                  | 2521    | 14.1     | 14.5     |
| 3.     | All India Co-ordinated trial  | 3             | 4037                   | 3167                  | 2930    | 27.5     | 37.8     |
| 4.     | ART trials                    | 79            | 3091                   | 2801                  | 2680    | 10.4     | 15.3     |
| 5.     | OFT trials (KVK)              | 58            | 2743                   | 2235                  | 1961    | 22.7     | 39.9     |
| 6.     | OFT trials (SI)               | 10            | 5801                   | 2457                  | 5610    | 139.3    | 5.2      |
| Mean   |                               | 185           | 3123                   | 2569                  | 2579    | 22.4     | 23.9     |

Sorghum is often grown for its dry fodder apart from grain to sustain a large population of animals in Tamil Nadu. Sorghum variety without dry fodder yield has no value in southern peninsular India. Considering the overall performance of the dry fodder yield the culture TKSV 0809 exhibited superiority of 11.9 t/ha, which was 31.8 and 40.7 per cent increased yield over the checks K 8 (9.2 t/ha) and CSV 17 (8.5 t/ha) (Table 4).

Table 4. Overall Mean performance of TKSV 0809 culture for dry fodder yield under different yield trials

| Sl. No. | Trials                        | No. of trials | Mean dry fodder yield t/ha | % increase over check |
|--------|-------------------------------|---------------|---------------------------|-----------------------|
|        | TKSV 0809                     |               | K 8 (c)                   | CSV 17 (c)            | K 8 (c) | CSV 17 (c) |
| 1.     | Station trials                | 5             | 13.92                     | 10.12                 | 7.81    | 37.5     | 78.2     |
| 2.     | Multilocation trials          | 2             | 11.32                     | 7.65                  | 6.33    | 48.0     | 78.8     |
| 3.     | All India Co-ordinated trial  | 3             | 4.27                      | 4.25                  | 3.41    | 1.0      | 25.2     |
| 4.     | ART trials                    | 44            | 10.7                      | 8.2                   | 8.4     | 30.5     | 27.4     |
| 5.     | OFT trials (KVK)              | 53            | 12.3                      | 9.0                   | 8.3     | 36.7     | 48.2     |
| 6.     | OFT trials (SI)               | 10            | 16.9                      | 15.9                  | 12.8    | 15.5     | 38.5     |
| Mean   |                               | 117           | 11.9                      | 9.2                   | 8.5     | 31.8     | 40.7     |

Sorghum production is greatly affected by a variety of insect pests and disease. The sorghum culture TKSV 0809 was screened against major pests and diseases along with checks (Table 5). The culture TKSV 0809 exhibited moderate resistance to shoot fly and stem borer as compared to checks. Besides the culture of TKSV 0809 was founded to be resistant to downy mildew and leaf spot diseases. (Table 6)

Table 5. The reaction of sorghum culture TKSV 0809 to pest incidence

| Sl. No. | Entries | Shootfly deadhearts 21 DAE | Shootfly deadhearts 28 DAE | Stemborer deadhearts on 45 DAE | Stemborer leaf injury on 45 DAE rating 1-9 scale |
|---------|---------|-----------------------------|----------------------------|-------------------------------|-----------------------------------------------|
| 1.      | TKSV 0809 | 13.8                        | 27.8                       | 18.5                          | 2.6                                           |
| 2.      | K 8 (c)  | 17.0                        | 22.0                       | 34.9                          | 3.0                                           |
| 3.      | CSV 17 (c) | 12.0                        | 16.4                       | 18.0                          | 2.0                                           |
| 4.      | Co S 28 (c) | 19.6                        | 29.1                       | 25.8                          | 3.3                                           |
| 5.      | Co 30 (c) | 18.9                        | 26.4                       | 25.1                          | 3.2                                           |

Table 6. The reaction of sorghum culture TKSV 0809 to different diseases

| Sl. No. | Entries | Downy mildew | Rust (1-9) | Grey leaf spot (1-9) | Anthracnose (1-9) |
|---------|---------|--------------|------------|----------------------|-------------------|
| 1.      | TKSV 0809 | 1.46 (R)     | 0.20 (R)   | 1.06 (R)             | 0                 |
| 2.      | K 8 (c)  | 2.21 (R)     | 0.30 (R)   | 2.82 (R)             | 0                 |
| 3.      | CSV 17 (c) | 1.89 (R)     | 0.26 (R)   | 2.52 (R)             | 0                 |
The nutritional status of the grain revealed that the sorghum culture, TKSV 0809 had superior nutritive qualities for protein (9.58%) over checks K 8 (8.71%) and CSV 17 (8.03) (Table 7).

Table 7. Nutritional quality of grains and fodder of sorghum variety K 12

| Sl. No. | Sorghum grain | Crude protein (%) | Crude fibre (%) | Ether extract (%) | Calcium (%) | Phosphorus (%) | Iron (ppm) |
|---------|---------------|-------------------|----------------|------------------|-------------|----------------|------------|
| 1.      | TKSV 0809     | 9.58              | 1.17           | 3.46             | 0.35        | 0.29           | 106.60     |
| 2.      | K 8 (c)       | 8.71              | 1.32           | 3.15             | 0.30        | 0.18           | 63.03      |
| 3.      | CSV 17 (c)    | 8.03              | 1.05           | 3.06             | 0.35        | 0.31           | 108.32     |

Similarly, the dry fodder samples of TKSV 0809 has revealed high protein content (6.55%) and crude fibre digestibility (53.3%) compared to the checks K 8 (48.3%) and CSV 17 (49.2%). Identification of superior dual-purpose (Food and fodder) sorghum variety is the need of the hour as it is the only way to meet the demand for food, feed and fodder of the country (Blummel and Reddy, 2006).

Besides high grain yield and the fodder yield it is photo insensitive variety suitable for growing in all-season where it is a deficit in K 8. This culture is a medium-tall variety with a plant height of 225 to 240 cm and also found non-lodging. Since it is a short duration variety matures in 95 - 100 days it escapes from terminal drought if occur in North-East monsoon. The grain colour is a creamy white colour and highly acceptable quality. It has a semi-compact cylindrical head covered with 1/3rd of glume. The dry fodder is highly acceptable with high dry matter digestibility (53.3%) over K 8 (48.4%). The average dry fodder yield is 11.9 t/ha.

Since the sorghum culture of TKSV 0809 exhibited superiority in grain and fodder yield and its nutritional qualities over the checks K 8 and CSV 17 under both rainfed ecosystems and in summer irrigated condition the sorghum culture was released as K 12 sorghum for commercial cultivation in Southern districts of Tamil Nadu.

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