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Description of cultivar

VCS-Fuego, a dual-purpose sorghum variety for the state of Sinaloa

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Abstract

The VCS-Fuego sorghum variety was developed at the Valle de Culiacán Experimental Field (CEVACU) of the National Institute of Forestry, Agricultural, and Livestock Research (INIFAP) and registered with the definitive number SOG-317-240521 in the National Catalog of Plant Varieties (CNVV) of the National Seed Inspection and Certification Service (SNICS) and breeder's title number 2968 in favor of INIFAP. It was developed from 2009 to 2017 in the state of Sinaloa, where hybrids or commercial varieties susceptible to diseases and plant lodging are predominantly sown. VCS-Fuego is a variety with an intermediate vegetative cycle, with amber grains; it is recommended for irrigated and rainfed conditions. The average yield of the variety is 3.95 t ha^{-1} of grain and 35 t ha^{-1} of fresh forage. VCS-Fuego has good bromatological quality in forage, with 6.72% protein and 79.07% digestibility, has a grain size of 5.03, 4.09, and 3.02 mm in length, width and thickness, and a chemical composition of proteins, lipids, and carbohydrates of 14.78, 3.62, and 80.03%, respectively; therefore, VCS-Fuego is proposed as a potential variety to be grown in the state of Sinaloa.

Keywords:

Sorghum bicolor, breeding, forage, yield.

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Sorghum (*Sorghum bicolor* L. Moench) is one of the oldest crops and one of the most important cereals in some countries in Africa, Asia, and the Americas (Dicko *et al*., 2006). It is characterized by its productivity in warm environments, such as those prevailing in semi-arid regions of the world (Serna-Saldívar, 2010). Sinaloa ranks third nationally in terms of sorghum planted area; in 2020, it was 116 590 ha; of this area, more than 60% is grown under rainfed conditions in the spring-summer cycle (SIAP, 2023).

Among the main problems faced by sorghum crops in the state is the fact that its sowing is mainly under rainfed conditions in dispersed areas, coupled with the poor distribution and amount of rainfall, as well as the scarce use of conservation practices and use of moisture.

In central and southern Sinaloa, commercial hybrids are predominantly sown under rainfed conditions, which are susceptible to diseases and plant lodging, making mechanical harvesting impossible and causing losses in grain yield. In recent years, in the sorghum genetic breeding program of the CEVACU, it has been possible to identify genotypes with greater tolerance to diseases than commercial hybrids; the VCS-Fuego variety presented greater tolerance to ergot caused by *Claviceps africana*, anthracnose caused by *Colletotrichum graminicola*, panicle blight caused by *Fusarium moniliforme*, and carbonaceous rot of the stem caused by *Macrophomina phaseolina* (González *et al*., 2005; Williams-Alanís *et al*., 2009).

The VCS-Fuego variety shows tolerance (scale 2) in the field to this complex variation of diseases in addition to presenting greater adaptation to conditions (climate and temperature) than commercial hybrids (Williams-Alanís *et al*., 2009); currently, VCS-Fuego is evaluated for its tolerance to the yellow sorghum aphid (*Melanaphis sacchari* Zehntner), where, so far, it has presented level 3 tolerance to this aphid (Sharman *et al*., 2013), considered one of the main pests in sorghum crops, which has registered losses between 30 and 100% of commercial lots due to severe aphid infestation (Maya and Rodríguez 2014).

VCS-Fuego variety registration

It is owned by INIFAP and is registered in the National Catalog of the SNICS with the definitive registration number SOG-317-240521 and breeder's title number 2968 in favor of INIFAP.

Origin

The VCS-Fuego sorghum variety was developed in the Sorghum Genetic Breeding Program of the CEVACU of the INIFAP; it was obtained through genetic recombination and selection. The germplasm that gave rise to this new variety was produced through a process of hybridization and genealogical selection, starting with the F1 cross (innate) in the CEVACU in 2009 from some ICRISAT's heterogeneous lines introduced, without parental identification, locally named as BT09T9R.

The first F1 generation (2009-2010) was mass (M) harvested; from the second generation (2010-2014) (F2), individual selection was made by size and type of panicle, exertion, height, plant health and earliness until the fifth generation (F5). From the sixth to the seventh generation (2014-2017) (F6 to F7), it was harvested in a mass way; through this process, a homogeneous line was achieved, which gave rise to the VCS-Fuego variety, whose pedigree is BT09-T9-M-2-5-3-1-M-M.

Varietal description

It was carried out using the descriptors of the Union of Producers and Breeders of Varieties (UPOV, for its acronym in Spanish) under rainfed and irrigated conditions in the south and center of Sinaloa. In the spring-summer cycle under rainfed conditions, VCS-Fuego showed a behavior of intermediate vegetative cycle, with 65 to 72 (Table 1) days to flowering and 105 to 110 days to harvest, with necessary requirements of average heat units of 711.9 to flowering and 1 363.5 to harvest.

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Table 1. Average grain yield and agronomic characteristics of four sorghum genotypes grown in six environments in the state of Sinaloa.

Genotype	Grain yield (t ha^{-1})							Agronomic traits (Average of six environments)						
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Aver	DF	PH	PL	EXE
VCS-Fuego	3.95a	3.87a	3.9a	3.8a	4a	4.22a	3.97a	3.92a	3.77a	4a	3.95a	70.2a	3.1a	22.7a	19.5a
Milón*	2.77b	2.7b	2.6b	2.7b	2.8b	2.82b	2.82b	2.75b	2.6b	2.8b	2.75c	67.5ab	2.5b	19b	18.2a
Hegary*	2.75b	2.9b	2.57b	2.75b	3.12b	2.5b	2.47b	3b	2.75b	3.17b	2.8bc	64.2bc	2.3c	17b	18.2a
Silomiel*	2.62b	2.8b	3b	2.82b	2.72b	3.07b	3b	2.92b	2.9b	3b	2.9b	61.2c	2.3c	18.5b	17.5a
Mean	3.02	3.06	3.01	3.01	3.16	3.15	3.06	3.15	3	3.24	3.1	61.2c	2.59	19.31	18.37
CV (%)	5.2	6.5	9.5	9.04	6.21	9.8	11.05	7.51	11.22	7.5	1.86	3.3	2.45	6.91	9.64
$LSD_{0.05}$	0.35	0.44	0.63	0.6	0.43	0.68	0.74	0.52	0.74	0.53	0.12	4.8	0.14	2.94	3.91

Genotypes with the same letter in a column are statistically the same (Tukey, 0.05). *= commercial control; DF= days to flowering; PH= plant height (mts); PL= panicle length (cm); and EXE= exertion of panicle (cm).

It has a plant height of 3.1 m and its leaves are light green with a medium texture without anthocyanins (Figure 1). VCS-Fuego developed, at maturity, a stem with eight internodes; the juice extracted from the stem has a high content of soluble solids, which, in the phenological state of milky-doughy grain, range from 18 to 19 °Brix. It has medium spikes (panicle length 22 cm), semi-compact, with good exertion 19 cm, and glumes without anthocyanins in flowering; the grain is amber, elliptical, and semi-flattened, with crystalline testa and endosperm and medium texture (Figure 2).

Figure 1. VCS-Fuego sorghum plant.

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Figure 2. VCS-Fuego sorghum panicle.

Regarding grain yield, it was observed that the VCS-Fuego variety was the one that presented the best yields in the evaluation cycles, with an average yield of 3.95 t ha^{-1}, 1 t ha^{-1} higher than the commercial controls evaluated. In the evaluation cycles, the VCS-Fuego variety showed to have the best panicle length; this characteristic may influence it to be the variety that presented the highest grain yields (Table 1).

Its forage production was evaluated during the spring-summer cycles; VCS-Fuego showed average yields of 35 t ha^{-1} of fresh forage, higher on average than the commercial controls 14.7 t ha^{-1}; this characteristic of fresh forage yield can be attributed to the size of the plant presented by the VCS-Fuego variety, 3.1 m (Table 1). It has a bromatological forage quality of 79.07% digestibility and 6.72% protein, higher than commercial controls with averages of 53.2% digestibility and 5.14%protein.

The level of yield and bromatological quality of forage places the VCS-Fuego variety as a dual-purpose material, whose potential can be used for silage (Hernández-Espinal *et al*., 2010). On the other hand, the physical and chemical analysis of the sorghum grains found that the physical dimensions of this variety (length, width, and thickness) were 5.03, 4.09, and 3.02 mm; respectively, it has been reported that sorghum grains are typically round, although most have a flattened part (Reichert *et al*., 1988); in commercial varieties and hybrids, it has been shown that sorghum grains have average values of 4, 2.5, and 2 mm in length, width and thickness, respectively (Rooney and Serna, 2000).

For its part, the weight of 1 000 grains of the VCS-Fuego variety is 35.53 ±0.26 g. Due to genetic diversity, sorghum grains can vary in shape and size; Rooney and Serna (2000) report that the weight of 1 000 grains of sorghum can vary from 30 to 80 g depending on the cultivar and the climatic conditions where they were grown.

The chemical composition of the sorghum grains of the VCS-Fuego variety presented percentages of protein, lipid, and carbohydrate content of 14.78, 3.62 and 80.03%, respectively; various studies have reported that sorghum contains a protein range from 10.4 to 12.41%, as well as lipid ranges from 3.1 to 3.6% (Rooney and Serna, 2000), considered to be of good quality for the production of animal feed. For the production of this variety, it is suggested to use the technological package developed by INIFAP for the state of Sinaloa (Moreno *et al*., 2020).

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Seed availability

INIFAP makes the VCS-Fuego seed available to the general public; interested producers can go to the Valle de Culiacán Experimental Field and submit their request for seed needs.

Conclusions

The VCS-Fuego variety is a good alternative to be grown in the state of Sinaloa; in addition, it shows better bromatological quality than commercial hybrids, its seed is easier to reproduce, and farmers can generate their own seed and with this there will be a significant reduction in costs.

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