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A Proliferation of the Sorghum Spikelets.

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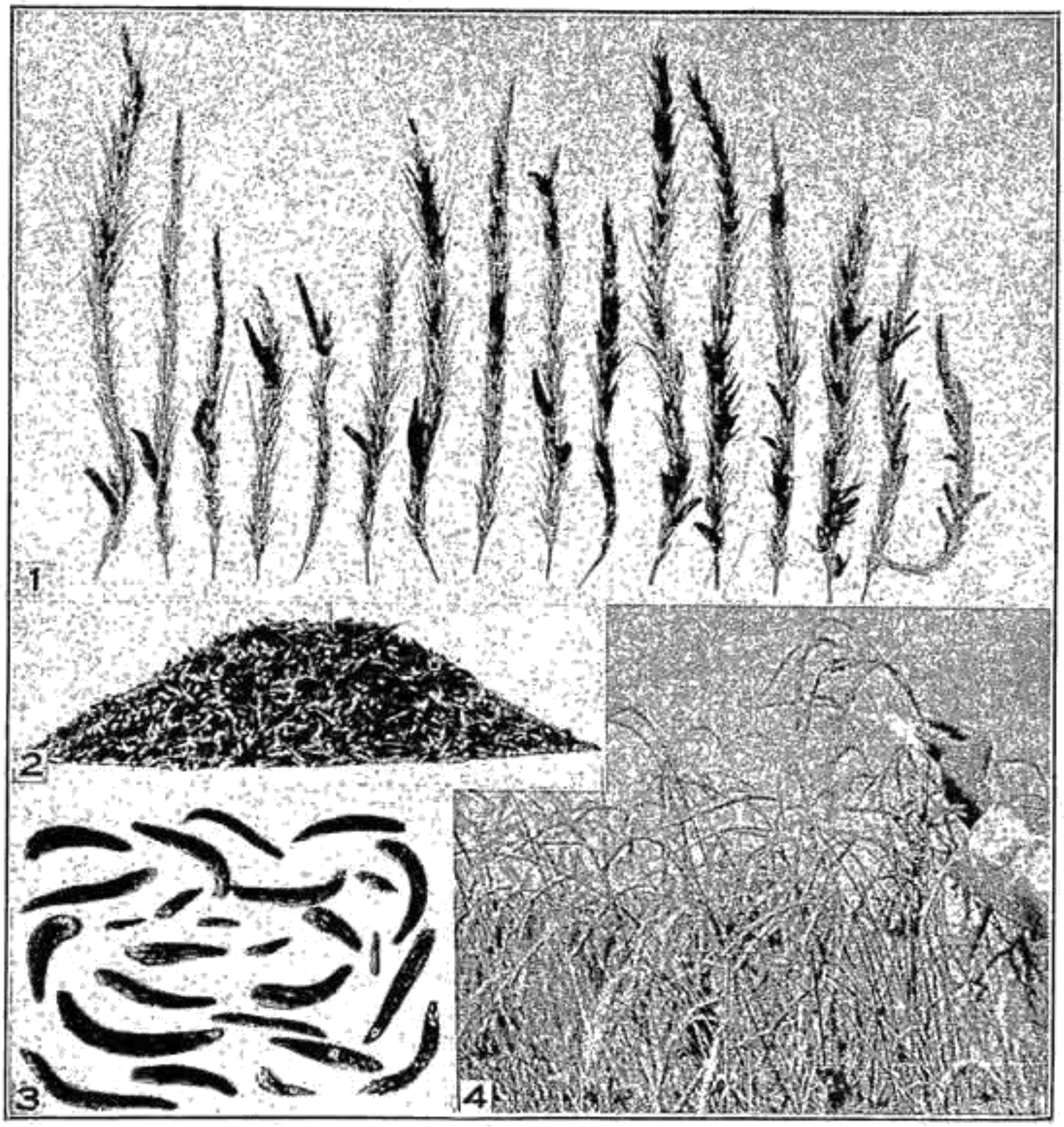
An interesting phenomenon of proliferation of a sorghum earhead was observed in the summer season of 1940 in a seed multiplication plot of an yellow grain sorghum strain (A. S. 809). While removing rogues at the flowering time, one earhead was observed to have rather longer spikelets, though in other respects, the plant was normal. The plant was as well developed and as tall as its neighbours, and the size and shape of the earhead also appeared normal. A closer examination of the earhead revealed that the fertile spikelets had not opened. While the spikelets of the normal plants were awned, the awns being about one centimetre in length, there was a complete suppression of the awn in the proliferated earhead. It was also observed that the spikelets in the basal regions of the earhead were reduced to scale-like structures.

A few days later two more earheads with proliferated spikelets were obtained from a neighbouring field sown with the seed of the same stock. This field was also sown about the same time as the previous one and the plants in this also flowered about the same time. In these earheads it was observed that some of the spikelets had developed into seedlings, which appeared like normal sorghum seedlings about a fortnight old.

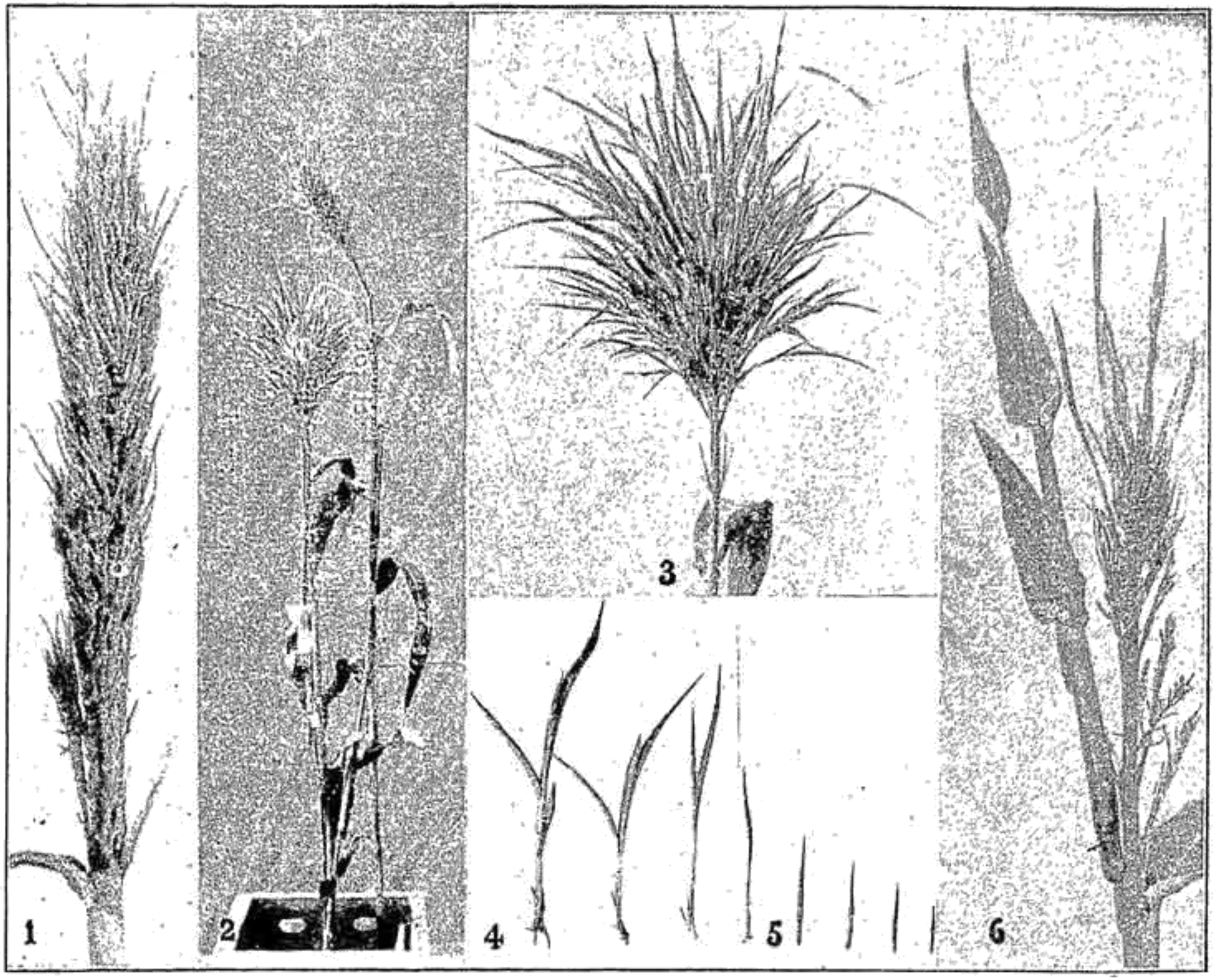
A few seedlings were detached from the earhead and kept in water for examination. They developed roots. These and a few more seedlings from one of the earheads were planted in pots filled with soil. All of them survived, grew up and in about 50 days developed earheads. These earheads also were abnormal. The spikelets were longer and developed into 'seedlings'. Seedlings from this when about three weeks old were again planted. The abnormality was thus perpetuated.

In the second generation raised in pots it was observed that the seedlings developed roots while still attached to the earhead, as they were



ERGOT PRODUCTION IN MADRAS

1. Ear-heads of rye showing ergot sclerotia.
2. A heap of ergots collected from an experimental field on the Nilgiri hills.
3. Individual sclerotia showing variations in size and shape.
4. A portion of an inoculated field of rye. Note the bunch of infected ears.



EXPLANATION OF PLATE

Fig. 1. A proliferated earhead, about one week after emergence.

Fig. 2. Two plants with proliferated earheads, grown in a pot, about three weeks after emergence of the earheads.

Fig. 3. A closer view of one of the earheads in Fig. 2.

Fig. 4. Seedlings with roots, separated from a proliferated earhead.

Fig. 5. Early stages in the proliferation of the spikelets.

Fig 6. A branch of the earhead modified into a shoot.

exposed to rainy weather. And in a few cases in which the earheads were retained on the plants for a longer period, stray seedlings completed their life-cyle on the earhead, without dropping off, and in their turn produced proliferated earheads. These had 12 to 13 leaves, including the spikelet parts, which is the same as for normal plants of the variety; only the plants were much reduced in size.

A critical examination of the earheads revealed that both the sessile (grain bearing) and pedicelled spikelets proliferated. When the spikelets were examined at the early stages, soon after emergence of the earhead, some were observed to contain both ovary, with style and stigma, and anthers, but reduced in size compared to those in normal spikelets. But in most of them no sexual organs were noticed. In these both the glumes and lemmas and paleae were herbaceous. In some cases it was also noted that the branches in the lower whorls of the earheads were suppressed, and in rare cases 'shoots' were produced in place of branches.

Proliferated spikelets when examined about a fortnight after the emergence of the earhead were observed to have five glume-like, but much elongated basal leaves, and two to three well developed normal leaves with sheath, junction, and blade, well differentiated. These when planted continued to grow, producing more leaves from the apex, while in a few cases, terminal growth was arrested and sideshoots developed from the axillary nodes and grew up. In all these the adult plants appeared healthy and bore only proliferated earheads.

As stated above, this phenomenon was first observed in a summer season crop. This crop is sown in the month of March, and the flowering period of the plants is in May. To see whether this phenomenon is affected by weather conditions, 200 seedlings were planted in a field in September 1940. All of them repeated the same phenomenon. In no case was there any seed production. Another 100 seedlings were planted in April, along with the 1941 summer season crop. In this trial also none produced any seed. All bore only earheads with proliferated spikelets.

Sap extracted from seedlings borne on a proliferated earhead was injected, with a hypodermic syringe, into young seedlings raised from normal seeds. These produced only normal earheads with seed. Selfed seed from these, when sown, produced only normal earheads with good seed. Cytological examination of the root tips of the proliferated spikelets revealed no chromosomal peculiarities or aberrations.

Proliferations of the sorghum earhead have been previously reported from America. Laude and Gates (1929) reported a 'proliferated' earhead of sorghum, in which a series of glume-like structures replaced the floral parts in the spikelets. The spikelets were about normal in size. Karper (1936) also has recorded an instance of similar proliferation. A similar earhead was obtained at the Millet Breeding Station, Coimbatore, but not reported hitherto.

Karper (1936) has recorded an instance of proliferation almost similar to the one described in this paper. He observed this in a large number of plants which were localised in one half of a field of Kafir. None was observed in the other half, which was sown on a different date, nor in other fields sown with seed from same stock. The number of vegetative shoots varied widely in different heads, ranging from only a few to practically 100 per cent, and normal seed bearing spikelets were found interspersed with the 'shoots' throughout the inflorescence. The plants bearing these heads were abnormal, profusely tillering and producing a bunchy growth. But no roots or root-like structures were observed in the 'shoots'. He did not test the ability of these 'shoots' to survive independently of the mother plant. The progeny raised from seed of these abnormal plants did not repeat this phenomenon. So he concluded that "the most likely cause of the phenomenon appears to be an unusual combination of environmental factors encountered by those particular plants at a critical stage in the early development of the reproductive organs".

Rangaswami Ayyangar and Panduranga Rao (1935) have recorded the development of bulbils in place of grains in the sorghum panicle. These were noted in double or multiple-seeded spikelets in which one of the seeds, in stray cases, was transformed into a bulbil. In these the two outer glumes of the spikelets were normal. Ranaswami Ayyangar and Ponnaiya (1939) later observed that these bulbils when planted in soil could survive, and one such plant obtained from a bulbil, though weak in development, produced a small earhead with a few spikelets, which were normal in appearance but devoid of normal sexual organs.

There are a few instances of similar abnormality in other plants also. Ganguly (1936) has recorded a complete proliferation of the reproductive spikelets into potential vegetative shoots in maize. Reeves and Stansel (1940) have described anamalous vegetative prloiferation of the spikelets and the plants in general, in maize and teosinte. They ascribed this phenomenon to environmental conditions. Collins and Kempton (1916) observed 'little plants' in place of spikelets in the terminal inflorescence in the F_2 generation of a cross between *Triposcum* and *Euchlaena*, and several of these little plants developed roots while still attached to the parent plant, and when separated and planted in pots grew up and matured seeds. Plants from seed thus produced behaved like those from self-pollinated seed of second generation plants. They observed 'apogamous' plants in place of spikelets in *Euchlaena* also, in one season. Kostoff (1940) observed similar abnormality in the perennial plants among the progeny of the backcross *(Secale cereale* × *S. montanam)* × *S. cereale* in the eighth generation, when they were grown at a low temperature. The shoots had rootlets and when planted survived. When they were grown in a temperature of above 15°C they developed into normal plants. All the plants produced by 'viviparous propagation' set quite normal seeds during summer. So, he also concluded that the proliferation is the result of environmental (temperature) conditions. Krishnaswami and Rangaswami Ayyangar (1942) observed 'leafy bunches' in place of panicles in the second generation progeny of X-rayed seed of *ragi* (*Eleusine coracana* Gaertn.), and also as stray plants in natural populations from bulk seed. These 'leafy bunches' developed roots and when planted survived and repeated the same behaviour. In the third generation of the X-rayed seed partial foliation was also observed. Subsequently Krishnaswami (unpublished) has observed the repetition of the phenomenon in the fourth generation in the progenies of apparently normal plants. This indicates its heritability and the possibility of its perpetuation through seed. Arber (1934) has recorded instances of proliferations of the spikelets in a few grasses—*Poa alpina* L. f. *vivipara* L., *Phleum pratens* L., *Festuca ovina* L. and *Arrhenatherum avenaceum* Beauv., and in the bamboos. In a submerged plant of *Deschampsia caespitosa* Beauv. var. *rhereana* Grem., she observed flower production was entirely inhibited in favour of proliferation, while in other plants of the same species which were not swamped bore flowers and fruit. She has further stated that in the same variety a race is known in which this peculiarity is heritable and not controlled by environment. So, she concluded that there are two classes of proliferation, that controlled by environment and that which is innate and hereditary. She has added that "cytological examinations have shown a chromosomal basis for some instances of proliferation, e. g., in *Festuca ovina* L. and in some wheat crosses. Nielsen (1941) observed proliferations of the spikelets in *Festuca obtusa* Spreng., *Bromus inermis* Leyss., *B. purgans* L., *Phleum pratens* L., *Avena sativa* L. and *Panicum virgatum* L., and attributed these to adverse environmental factors or abrupt changes of environmental factors particularly moisture, light and perhaps temperature.

The proliferation described in this paper differs from 'bulbils', as in the latter the two outer glumes of the spikelets in which the seeds are transformed into bulbils are normal and similar to the glumes in seed-bearing spikelets. In the instance recorded by Karper, he observed both seed-bearing spikelets and 'shoots' on the same earhead, whereas no such instance was met with here. Moreover he observed no roots or root-like structures in the 'shoots'. Further, the phenomenon which is described here is not season bound or affected by environmental or weather conditions. This is a new experience in sorghum not previously recorded.

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