present report appears to be the first record from this hill. Thus it is evident that the rusts occurring naturally on *Agropyron* spp. and wheat are the same, and *A. yukonense* and the other *Agropyron* spp. are the collateral hosts of pathotypes 117A and 40A respectively. The existence of specialized form of *P. graminis tritici* on *Agropyron* spp. can be ruled out, since no *Agropyron* sp. is known to occur naturally in the Nilgiri hills. Some *Agropyron* spp. have been reported to take infection of *P. graminis tritici*[3–5].

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INTERSPECIFIC HYBRID BETWEEN *AMARANTHUS SPINOSUS* (SECTION AMARANTHUS) AND *A. VIRIDIS* (SECTION BLITOPSIS)

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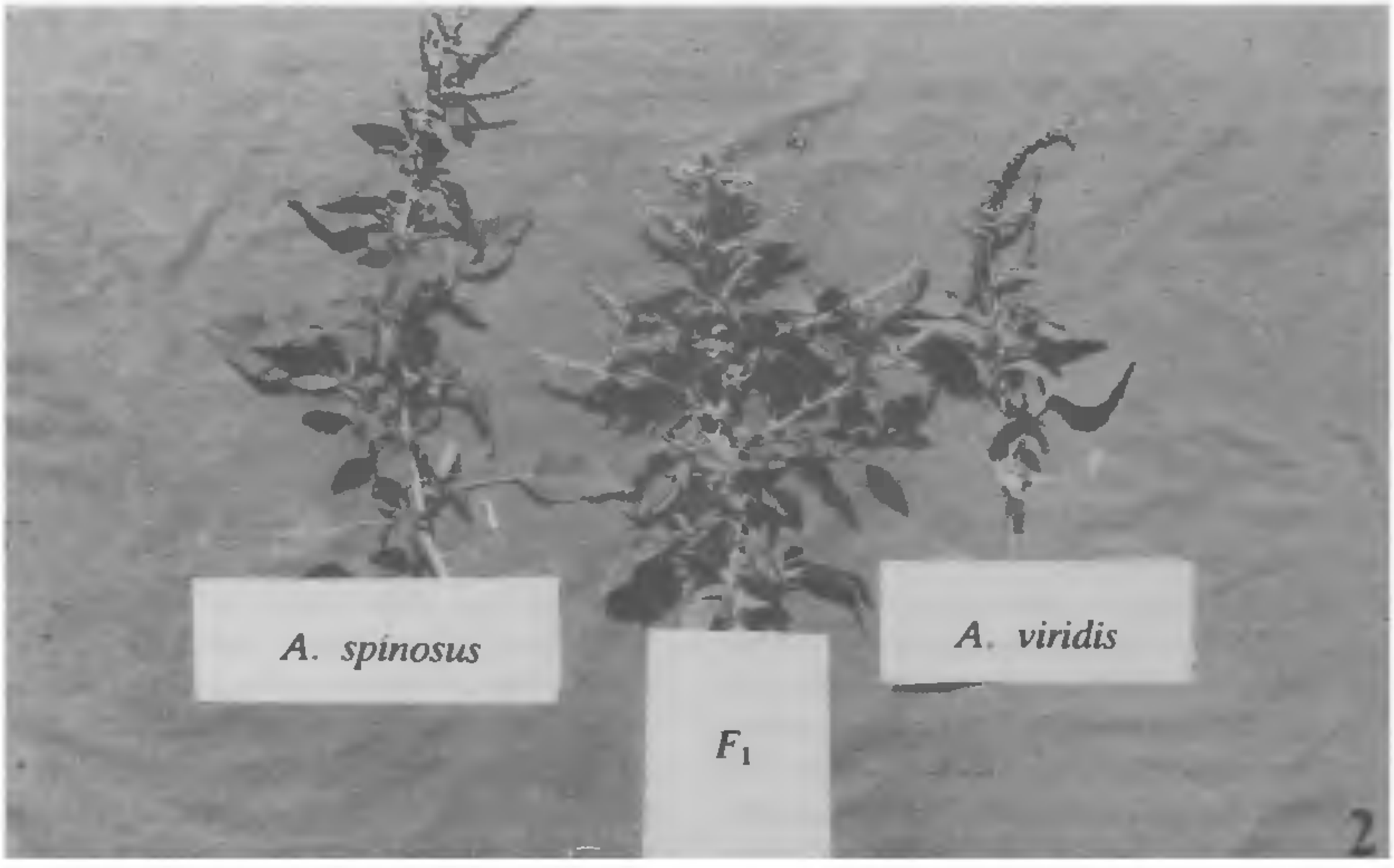
THE genus *Amaranthus* is divided taxonomically into two sections—Amaranthus Sauer (Amaranthotypus Dumort) and Blitopsis Dumort. The prominent axillary inflorescences and trimerous flowers distinguish Blitopsis from Amaranthus having prominent terminal inflorescences and pentamerous flowers[1]. Based on cytogenetical features, breeding systems and morphological characters. Khoshoo and Pal[2] established the identity of these two sections. Also a number of naturally occurring hybrids were reported within each section[3]. However, no report is available on the existence of natural hybrids or on the successful attempt of interspecific hybridization between these two sections. In this paper, we report the first success of hybridization between two wild cosmopolitan species, *A. spinosus* ($n = 17$) and *A. viridis* ($n = 17$) belonging to sections Amaranthus and Blitopsis respectively.

Artificial hybridization was attempted by taking *A. spinosus* as female parent and *A. viridis* as male parent. The two species do not seem to be easily compatible. The hybrid was produced by removing the terminal part of the panicle consisting of male flowers in *A. spinosus* and then dusting with the *A. viridis* pollen on to the receptive stigmas. Pollination was restricted to only a single branch of the *A. spinosus* plant because of the limited pollen production in *A. viridis*. The hybrid seedling could be distinguished from among the selfed seedlings even at early stages due to the presence of broader and thicker leaves and rosetted growth. The hybrid plant flowered only after three months by which time the parents had almost completed their flowering. Meiotic studies were carried out in the parent species and interspecific hybrid using pollen mother cells, for which young inflorescences were fixed in Carnoys II fluid (6 alcohol : 3 chloroform : 1 acetic acid) mixed with a few drops of saturated ferric acetate solution. After 48 h of fixation, the buds were squashed in 1% acetocarmine[4].

The hybrid plant, unlike the parents had a short and sturdy stature tending to become perennial in growth habit (figure 1). The stem was stout and strong with very short internodes. The leaves were typically ovate with a leathery consistency. In the hybrid, an overall dominance of major *spinosus* characters were observed for the presence of axillary spines, distinct placement of pistillate and staminate florets, size of the florets, pentamerous symmetry, etc. (figure 2). The staminate florets were limited to a small distal area of the panicle; but the pistillate flowers were produced profusely towards the proximal side. Most of the male flowers were barren but a few contained 5 stamens. The male flowers failed to open and the anthers dried off without any dehiscence.

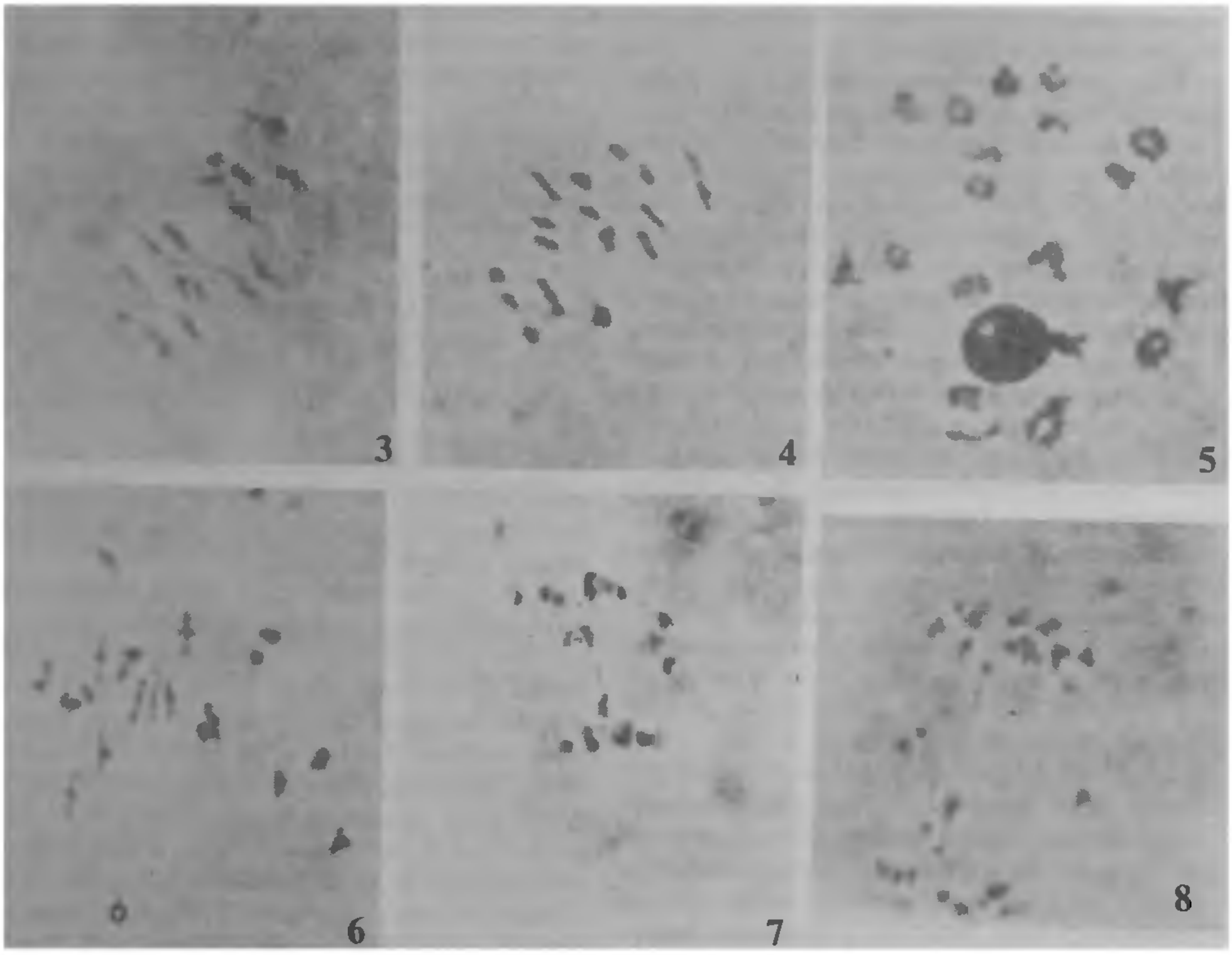
Meiosis was quite regular in both the parents and 17 II were observed at metaphase I stage (figures 3 and 4). The bivalents showed one or two chiasmata and normal disjunction. Also pollens and seeds were quite fertile. The interspecific hybrid, on the other hand, showed an average frequency of 14.37 bivalents and 5.25 univalents at metaphase I stage of meiosis (table 1, figures 5 and 6). The univalents failed to orient at metaphase I, and led to abnormalities at subsequent stages. Anaphase I was often characterized by unequal distribution, lagging chromosomes, dicentric bridges, fragments, etc. (figures 7 and 8). PMC also showed abnormalities in the second meiotic division in the form of asynchronous orientation and disjunction at metaphase II



Figures 1 and 2. **1.** Plant morphology of *A. spinosus* × *A. viridis* hybrid, and **2.** Flowering twigs of the hybrid and parents in *A. spinosus* × *A. viridis* cross.

and anaphase II, respectively. These abnormalities often led to more number of nuclei than normal at telophase II (above 4) and about 40% of the cells carried 5 or more nuclei towards the end of meiosis just before tetrad formation. The hybrid plant showed about 62.57% pollen sterility and the sterile micropollen amounted to 14%.

The high frequency of bivalents (14.37 ± 0.16) and the moderate fertility of pollen (37%) in the hybrid indicated the extent of genomic similarity and hence



Figures 3–8. **3.** Chromosomes at metaphase I in *A. spinosus* showing 17 II; **4.** Chromosomes at metaphase I in *A. viridis* showing 17 II; **5–8.** Meiosis in the hybrid *A. spinosus* × *A. viridis*; **5.** Chromosomes at diakinesis showing 15 II and 4I; **6.** Metaphase I showing 14 II and 6 I; **7.** Dicentric bridge at anaphase I resulting from desynapsis of bivalents and lagging univalents, and **8.** Late anaphase I indicating broken bridge, fragments and lagging univalents.

phylogenetic relationship between *A. spinosus* and *A. viridis*. The presence of a few univalents in the hybrid is due to the reduced homology between certain pairs of chromosomes of the two species. Thus the results do not support the taxonomic treatment of these two genomically related species under two different sections[2]. Morphological and cytogenetical studies on other species and hybrids of

Table 1 *Chromosome association at metaphase I and pollen fertility*

Species/hybrid	Mean configuration		Mean Xta per PMC	Pollen fertility (%)
	II	I		
A. spinosus	17	—	23.64 ± 0.25	90.20
A. viridis	17	—	27.44 ± 0.22	81.60
A. spinosus × *A. viridis*	14.37 ± 0.16	5.25 ± 0.40	24.12 ± 0.59	37.43

both sections also failed to support to naturalness of the two sections in the genus *Amaranthus*[5]. On the basis of detailed investigations on interspecific hybrids within sections Amaranthus and Blitopsis, Pal and Khoshoo[6,7] suggested that the speciation within section Amaranthus involved cryptic structural changes of chromosomes and genetic drift whereas within section Blitopsis it was due to translocations involving 4–14 chromosomes. Cytological details of *A. spinosus* × *A. viridis* hybrid do not indicate chromosome repatterning by translocation, because of the absence of multivalent formation in PMCs. On the other hand, cryptic structural differences and genetic drift may be the factors responsible for the distinctness of the two species. Such cryptic differences between chromosomes resulting in genetic imbalance and probably early terminalization of chiasmata because of inadequate homology leading to noncoorientation of participating chromosomes may be responsible for the reduction in pollen fertility of the interspecific hybrid.

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JAGGERY SOLUTION—A COMPLETE NUTRIENT MEDIUM FOR MULTIPLICATION OF *RHIZOBIUM*

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YEAST-EXTRACT-MANNITOL (YEM) medium is generally used for preparation of *Rhizobium* inoculants. Mannitol and yeast-extract, the two expensive ingredients of this medium escalate the cost of production. In view of the growing demand of rhizobial inoculants, it is imperative to search for cheap and readily available alternatives to these costly ingredients. A good nutrient source requires faster rhizobial multiplication and lower production of gum in liquid medium.

In the present study, 1% aqueous solutions of commercial quality molasses, malt-extract, jaggery, peptone and yeast-extract were used as the sole source of nutrients. YEM broth[1] was used as a standard medium for comparison. These media were sterilized at 10 p.s.i. for 30 min in an autoclave. On cooling, they were inoculated with freshly grown broth cultures of *R. trifolii* (RC1–4), a fast grower and *R. japonicum* (SB–16), a slow grower and incubated on a rotary shaker (120 rpm) for 48 h in case of the former and 72 h of the latter at 32 ± 2°C. The rhizobial number in each broth culture was enumerated by dilution and plate method using yeast-extract-mannitol-agar medium containing congored[1]. The results are summarized in table 1.

Among different media used, jaggery solution supported maximum growth of slow as well as fast growing strains of *Rhizobium* though it was not comparable to standard YEM broth in this regard (table 1). This suggests that jaggery has intrinsic nutritional value more than other substances tested for the growth of slow and fast growing strains of *Rhizobium*. As Indian[2] and Australian[3] standards

Table 1 *Counts of Rhizobium trifolii and Rhizobium japonicum in six different media*

Organism	Log number of viable rhizobia/ml of broth					
	YEM	Molasses	Malt-extract	Peptone	Jaggery	Yeast extract
R. trifolii (RC1–4)	10.31	9.65	8.65	8.83	10.17	9.16
R. japonicum (SB–16)	10.13	9.22	8.69	7.87	9.93	8.97

S.Em. = 0.05; C.D. at 5% = 0.15.