

CHINA

A Brief report on screening excellent accessions of vetiver grass

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1 Experimental materials

The tried materials had 12 accessions of vetiver grass together (Table 1). Among them Accession 1~10 were collected from 5 different countries and regarded as good ones in the locality. The 10 accessions were first introduced into an experimental nursery of USA by Mr. Mark Dafforn and Dr. Robert P. Adams for a stretch of time, and then sent to the author in July 1999. The delivery lasted 10 days (July 28th to August 7th) in hot summer and furthermore all seedlings were all root-naked, but each accession survived a part. This indicates that vetiver really has strong vitality and can resist high temperature and long drought. Their survivals, however, showed a big difference, varying from 17% to 91%, indicating that they were different in relation to the ability to resist high temperature and drought.

Table 1 Resource of the tested materials and their performance at the time of introduction

No.	Ecotype	Origin	Tiller number at planting	Tiller number 15 d after planting	Survival rate
1	Capitol	U.S.A.	6	1	17
2	Huffman	U.S.A.	5	3	60
3	Sunshine	U.S.A.	3	1	33
4	Lilongwe	Malawi	11	10	91
5	Zomba	Malawi	7	5	71
6	Kandy	Sri Lanka	4	2	50
7	Karnataka	India	3	2	67
8	Malaysia	Malaysia	5	2	40
9	Parit Buntar	Malaysia	3	2	67
10	Sabak Bernam	Malaysia	7	2	29
11	Domesticated	Guangdong, China	/	/	/
12	Wild	Guangdong, China	/	/	/

Ecotype 11, introduced from abroad in 1950s, is the widely domesticated accession of China. The DNA fingerprinting reveals that the Domesticated is the same genotype as the most extensively cultivated variety around the world, Sunshine (Ecotype 3), but it had been cultivated for nearly 50 years and therefore some physiological, ecological or morphological features probably took place. Ecotype 12 was sampled from the wild vetiver community of Wuchuan County, Guangdong Province. The community, lied in the wetland near the bayou to the sea, has existed for hundreds of years; no one knows its genuine genesis. Furthermore, the vetiver of the community has distinct disparities with the widely cultivated variety (Domesticated) in the aspects of morphological characteristics and ecological features. Because of the reasons above, it is named as “Wild” ecotype presenting a striking contrast to the Domesticated one.

2 Results

2.1 Growth situation of plant height of different ecotypes

The growing speed of the tested 12 vetiver accessions is listed in Table 2. Prior to planting (October 2000), all materials were cut to 30 cm high; after 14 months of growing, different ecotypes produced tangible differences regarding plant height. At the last investigation, the highest ecotype was the Huffman, whose average height was 288 cm and the highest slip of the ecotype was up to 305 cm, whereas the lowest one was the Karnataka, whose average height was only 176 cm and the lowest slip 170 cm only. That is to

say that the maximum gap of plant height was up to 135 cm. Actually, their height revealed only a little difference during the vegetative growth stage. For example, at the June's observation, the highest ecotype (Capitol) averaged 197 cm while the lowest (Zomba) 153 cm, only a 44 cm disparity between them both. It can be seen, therefore, that the huge difference of plant height results mainly from reproductive growth. In addition, during the period of the whole investigation, especially in the early growth phase, the Karnataka's leaves seemed to be greener than those of other accessions. Among them Lilongwe had the lightest leaf color, and other 10 ecotypes were between them both, which were very difficult to discriminate from with naked eyes.

Table 2 Comparison of plant's growing speed of 12 vetiver ecotypes

No.	Accession	Oct.	Dec.	Feb.	April	June	Aug.	Oct.	Dec.
1	Capitol	30	79	76	124	197	217	259	276
2	Huffman	30	76	82	125	194	231	288	291
3	Kandy	30	82	88	127	171	189	235	237
4	Karnataka	30	66	64	94	160	171	176	178
5	Lilongwe	30	63	68	87	170	226	246	250
6	Malaysia	30	52	55	105	160	191	211	227
7	Parit Buntar	30	71	72	109	180	223	273	279
8	Sabak Burnam	30	76	75	110	186	225	265	275
9	Sunshine	30	73	70	122	186	228	271	275
10	Zomba	30	67	66	78	153	221	251	269
11	Domesticated	30	73	70	122	186	228	271	276
12	Wuchuan	30	74	71	130	192	237	274	280

2.2 Tiller formation situation of different ecotypes

After vetiver was planted for only one month (November 2001), the number of tillers of different ecotypes was significantly different, and furthermore the difference became bigger and bigger as time passed. 14 months later, namely at the last investigation, the ecotype yielding the largest number of tillers was Kandy, which yielded 82.5 tillers averagely for each clump, while the ecotype yielding the smallest number of tillers was Zomba, only 31.5 for each clump, and therefore a huge gap of 51 tillers between them both was formed as shown in Table 3. So, Kandy is undoubtedly far better than other accessions, Karnataka and Domesticated second, and Zomba poorest with special regard to the speed of tiller formation.

Table 3 Accumulative tiller number of each clump of different ecotypes during the growing period

No.	Ecotype	Oct.	Dec.	Feb.	April	June	Aug.	Oct.	Dec.
1	Capitol	3	3.5bc (1.19)	7.5abcd (1.94)	14.3cd (2.66)	21.8cde (2.84)	33.8cde (4.19)	44.5bcd (4.66)	51.0cdef (4.67)
2	Huffman	3	3.3bc (0.63)	5.3bcd (1.31)	10.8cd (2.17)	18.5de (3.07)	30.8cde (4.82)	41.8bcd (4.17)	56.5bcde (2.53)
3	Sunshine	3	3.8abc (0.48)	7.0abcd (0.58)	14.5bcd (1.26)	22.0cde (1.87)	36.5cd (3.30)	43.5bcd (4.99)	59.0bcde (6.94)
4	Lilongwe	3	3.5bc (0.50)	5.8bcd (0.25)	13.5cd (1.32)	21.0cde (1.73)	30.5cde (2.47)	34.0de (2.08)	39.5fg (3.29)
5	Zomba	3	2.3c (0.48)	4.3d (0.63)	10.0d (0.58)	15.3e (2.29)	20.0e (0.91)	24.5e (1.19)	31.5g (1.04)
6	Kandy	3	5.3a (0.85)	9.5a (1.71)	24.3a (5.76)	42.5a (7.90)	55.0a (8.30)	66.8a (7.41)	82.5a (8.03)
7	Karnataka	3	5.5a (0.65)	9.0ab (1.41)	19.8abc (3.75)	36.0ab (3.46)	52.5ab (4.29)	55.8ab (4.72)	68.0ab (3.94)
8	Malaysia	3	3.5bc	4.8c	9.8d	17.0e	29.5de	37.3cde	44.0efg

			(0.29)	(1.03)	(1.89)	(1.22)	(4.13)	(7.20)	(7.56)
9	Parit Buntar	3	4.3ab	6.8abcd	17.0abcd	23.0cde	39.0bcd	47.5bcd	66.0bcd
			(0.63)	(1.11)	(5.34)	(4.24)	(7.55)	(8.29)	(6.92)
10	Sabak Burnam	3	4.5ab	7.8abcd	16.5abcd	28.8bcd	41.5abcd	49.0bcd	62.3bcd
			(0.65)	(1.11)	(2.50)	(3.20)	(4.29)	(4.93)	(5.55)
11	Domesticated	3	5.5a	10.3a	23.8ab	31.3abc	45.5abc	52.3abc	67.5ab
			(0.29)	(1.55)	(5.11)	(7.00)	(8.31)	(8.14)	(8.30)
12	Wuchuan	3	4.3ab	8.0abc	17.0abcd	25.0bcde	35.8cd	40.0bcde	49.0defg
			(0.25)	(1.08)	(1.29)	(2.65)	(4.84)	(4.67)	(4.42)
	Max-Min	3	3.2	6	14.3	27.2	35.0	42.3	51.0

Means (with (SE), n=4) followed by same letters in the same row indicate there is no a significant difference at 5% level according to LSD Test.

2.3 Earring and flowering situation of different ecotypes

In this experiment, that came into ears first was the Zomba, then in the order of the Wild, Sabak Bernam, Lilongwe, Kandy, Sunshine, Domesticated, Malaysia, Parit Buntar, Huffman, and Capitol. Their first ear occurred on August 9th, 12th, 18th, 21st, 23rd, 30th, September 1st, 8th, 8th, 17th, and 25th, respectively; the extreme difference was 46 days. However, the Karnataka did not produce any single ear all the time. Since the main spike-stalk of vetiver is usually 50~70 cm long, so this is the radical reason that all accessions suddenly become much higher in autumn whereas the Karnataka is much shorter than them (Table 2). In the succedent over 2 months, the earring speed for each accession was also different. Zomba, the earliest heading accession, did not produce the most number of ears in the end, while Capitol, the latest heading accession, eventually became one of accessions with the most ear number due to its exuberant reproductive growth (Table 4). It is worth noticing that the Karnataka accession did not ear, but it, too, entered the reproductive growth in this period, namely new, complete plants grew out directly from culm nodes. A mature tiller may produce 3~9 such plants, and a clump produce 30~40, which are generally 40~50 cm long or so. Because of these new plants, the Karnataka accession still kept green in winter but other accessions became brown of different extents. Due also to heavy stress of new plants, however, this accession became deflecting and even lodging, and its appearance became somewhat tousy.

Earring rate is referred to as percentage of numbers of ears to tillers. Obviously, it is more precise to compare the earring rates of different accessions than number of ears. For example, the final ear number of Kandy accession was about 1/6~1/3 of other accessions, but its earring rate was only 1/10~1/5 of other accessions (Table 4), which was due to its far more number of tillers than those of other accessions.

Table 4 Number of ears (No./clump) and earring rate (%) of 12 different ecotypes of vetiver

No.	Accession	Total ear number					Earring rate				
		Aug.9	Sept.9	Oct.9	Nov.9	Dec.9	Aug.9	Sept.9	Oct.9	Nov.9	Dec.9
1	Capitol	0	0	13	34	44	0	0	7.30	17.78	21.57
2	Huffman	0	0	16	22	23	0	0	9.57	11.22	10.18
3	Sunshine	0	1	24	30	30	0	0.62	13.79	14.85	12.71
4	Lilongwe	0	4	19	25	28	0	2.94	13.97	16.80	17.72
5	Zomba	1	5	21	26	30	1.25	5.68	21.43	23.81	23.81
6	Kandy	0	2	7	7	7	0	0.84	2.62	2.309	2.126
7	Karnataka	0	0	0	0	0	0	0	0	0	0
8	Malaysia	0	1	16	33	36	0	0.74	10.72	20.63	20.45
9	Parit Buntar	0	1	22	27	27	0	0.58	11.58	12.32	10.23

10	Sabak Burnam	0	3	30	36	36	0	1.61	15.31	15.93	14.45
11	Domesticated	0	4	26	36	37	0	2	12.43	14.68	13.70
12	Wuchuan	0	5	35	45	45	0	3.38	21.88	25.57	22.96

2.4 Roots biomass of different ecotypes

If vetiver had not massive roots, its ecological effectiveness would be weakened dramatically. Therefore, it is necessary to consider the growing situation of roots when screening excellent accessions. It can be seen from Table 5 that the biomass of roots for different accessions was of high difference. The least roots biomass was the Wild, and the most was the Zomba, in spite of the fact the latter had the poorest ability to produce new tillers.

Table 5 Root performance of 12 different vetiver ecotypes

Item	Ecotype 1	Ecotype 2	Ecotype 3	Ecotype 4	Ecotype 5	Ecotype 6	Ecotype 7	Ecotype 8	Ecotype 9	Ecotype 10	Ecotype 11	Ecotype 12
A*	0.87	0.82	0.88	1.25	1.44	0.77	0.42	0.51	0.97	0.58	0.57	0.39
B	50	60	60	20	30	40	80	70	60	70	40	30

Item A is the root weight (mg DW/tiller) per tiller, and Item B is percentage of the root amount with diameter <1 mm to the total root amount (%)

3 Comprehensive evaluation to the growing performance

It can be seen from the aforementioned results that the different ecotypes of vetiver present distinct differences regarding their growing performance. Almost each ecotype has its own advantages and has its own shortcomings, too; No any accession performs the most excellent in all aspects. In order to screen out the best accession on the whole, 12 ecotypes is divided into 12 grades, each grade is endowed with 1 point. This means that the best ecotype in a certain aspect is given 12 points, and the poorest one given 1 point, and the ones with same performance are given a mean value. Then accumulative point for each ecotype is figured out, the ecotype obtaining the highest points is obviously the best one the whole. Table 6 is the points of the 12 ecotypes in different respects and their total points. Karnataka ranks first, which is beneficial mainly from its non-earring and lowliness resulted from non-earring. In addition, the new plants yielded from culm nodes are found to be good seedling reproducing materials. Therefore, cut off the new plants from mother plants after they grow up to a certain length, say 30~40 cm, which not only increase new resource of seedlings, but also keep the mother plants' normal appearance from pressing bend. Kandy lies in the second; it has the rapidest tillering speed, its earring rate is very low and shape is quite good and therefore is also worth widely disseminating. The Domesticated and Sunshine belong to the same genotype and their points are quite near, indicating that the former has produced quite few changes even 50 years after being introduced to China. As regarding the Wild ecotype, the main reason getting the lowest points is no doubt associated with its long-term waterlogged habitat before. The waterlogged environment is disadvantageous to root growth and tiller formation. Although the Wild plants had grown in our nursery for two years before conducting the observation, they still did not obtain the identical or similar features as the Domesticated or other ecotypes.

Table 6 A comprehensive evaluation for the 12 ecotypes of vetiver

No.	Ecotype	Plant height	Total number of tiller	Tillering rate	Earring rate	A	B	Total points	Rank
1	Capitol	5	5	4	3	8	6	31	9
2	Huffman	1	6	6	10	7	8	38	7
3	Sunshine	6	7	8.5	8	9	8	46.5	1

4	Lilongwe	9	2	2	5	11	1	30	10
5	Zomba	8	1	1	1	12	2.5	25	11
6	Kandy	10	12	12	11	6	4.5	55.5	2
7	Karnataka	12	11	11	12	2	12	60	1
8	Malaysia	11	3	3	4	3	10.5	34.5	8
9	Parit Buntar	3	9	8.5	9	10	8	47.5	3
10	Sabak Burnam	7	8	7	6	5	10.5	43.5	5
11	Domesticated	4	10	10	7	4	4.5	39.5	6
12	Wild	2	4	5	2	1	2.5	17.5	12

A is the mean root weight per tiller, and B is percentage of the root amount with diameter <1 mm to the total root amount (See Table 5)

In sum, the Karnataka accession is evaluated as the best cultivation from the angle of growth and development. The experiment, however, did not measure the length of roots, so we have not yet known how long its roots grow. But another special experiment on Karnataka roots' growing speed and length is now ongoing. In addition to this, the Karnataka has not yet been applied for the purpose of erosion control and pollution mitigation, thereby its ecological efficiency remains to be investigated.

By the way, a new cultivar of vetiver was just bred out, whose leaf brims are golden and therefore look better than the common accessions. Its growing characteristics and physiological and ecological features will be investigated soon.

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