SEED LOSSES WITH DIFFERENT METHODS OF HARVESTING *PANICUM COLORATUM*

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ABSTRACT

Measurement was attempted of the total seed production from a seed crop of a Kabulabula form of Panicum coloratum *using slings to collect shed seed and a final harvest to collect seed remaining in the panicles. The production measured was* 410 *kg/ha. Of this* 95% *was from shed seed.*

Four different methods of harvesting were compared and their efficiency relative to the 410 kg/ha level of production was as follows: cutting and drying the cut material on hessian in the field—77%; shaking mature seed from panicles on seven occasions over a 15-day period—62%; reaping and binding and drying sheaves on racks indoors—44%; direct heading—30%.

Considering viable seed (based on a germination test after storage of the seed for seven months) the relative efficiencies of the four methods were 49%, 62%, 42% and 19%.

It was concluded that with the machinery at present available direct heading offers the best prospects for commercial harvesting of Panicum, *despite its low efficiency.*

INTRODUCTION

Many tropical and sub-tropical pasture species possess characteristics which make the measurement of seed yield and the harvesting of seed difficult. Among these are an indeterminate flowering habit, continuing vegetative growth while flowering and seeding, ready seed shedding in grasses and pod dehiscence in legumes. The problems which these cause in seed harvesting have been discussed in general terms by Strickland (1971).

Information on seed yield potential of many of these species is scarce although there are some records of high yields from experiments. *Paspalum plicatulum* grown in irrigation boxes under conditions of optimum water and nutrition by Chadhokar and Humphreys (1970) produced seed equivalent to 2270 kg/ha. The same species in the field produced 1360 kg/ha of seed (Humphreys, L. R.—personal comm.).

However, the yield of tropical and sub-tropical species from commercial harvests in Australia generally is low (Anon. 1970). There is a need therefore for information on the seed yield potential of these species and the efficiency of different methods of harvesting. This paper reports the results of observations made in this field with *Panicum coloratum*. The observations necessarily had to be confined to one season. Further observations, covering a range of seasonal conditions, are required to test adequately these different methods of harvesting.

MATERIALS AND METHODS

A two-year-old seed block of a kabulabula form of *P. coloratum* (CPI 16796) grown in rows about 1 m apart at the Samford Research Station of C.S.I.R.O. was used for the observations. It was prepared for the seed crop by cutting back with a forage harvester and fertilizing with phosphorus, potassium and sulphur (30 kg/ha of each) and nitrogen at the rate of 120 kg/ha. Soil moisture was favourable, 840 mm of rain being received between the dates of fertilizing and final harvest.

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Portions of this stand were harvested by different methods as follows:—

1. *Total collection*

Lengths of hessian 1.8 m wide were suspended by one edge from horizontal wires about 1.5 m high and about 0.6 m on either side of the row. The lower edges of the hessian were tied together between and round the plants near the base to form slings. These were erected before flowering. Shed seed was caught in the slings, from which it was collected on two occasions. At the second collection, on December 30, 1970, when virtually all seed had been shed, the panicles were removed, dried in calico bags and threshed.

2. *Cutting and drying in the field*

Plants were cut with a reaping hook and laid on hessian to dry in the field. On plots sampled by this method plants were cut: a) "high"—a short distance below the panicle, or b) "low"—about 0.3 m above the soil surface so that the samples consisted of most of each stem and its attached leaves. This harvest was done on December 15 and 16, 1970. Seed threshed from the panicles and that which had been shed on to the hessian during drying was cleaned and weighed separately.

3. *Shaking by hand*

Mature seed was shaken from the panicles into a bin. This was done on seven occasions, the first on December 15, and the last on December 30, 1970. Practically no seed remained in the panicles after the last harvest.

4. *With reaper and binder*

Eight contiguous rows (i.e. plot of 0.05 ha) of the seed block were harvested on December 17, 1970. Sheaves were immediately placed on drying racks protected from the weather. A large proportion (estimated at more than 50%, but not measured) was shed during drying but was retrieved. The remainder was threshed from the sheaves when dry using a combine harvester as a stationary thresher.

The reaper and binder was equipped with special trays, as described by Oman and Stark (1951), to retrieve some of the seed that shattered during harvesting. The trays were placed below the junction of the elevator and platform canvases and below the lower edge of the tying platform.

5. *By direct heading**

One plot consisting of four contiguous rows of the seed block were harvested with a combine harvester and the seed dried at 35°C. This harvest was made on December 18, 1970.

For methods 1-3 the plot sampled was a 4.0 m length of row. There were ten such plots for method 2 and five for methods 1 and 3. Each was sited at random. Material harvested by these methods was hand threshed and the seed sample cleaned by sieving and aspirating. Seed harvested mechanically was cleaned with a Clipper Model M-2B grain seed cleaner.

After cleaning seed was stored in calico bags at 10°C and 30% R.H. After seven months storage, germination was tested at alternating temperatures of 20°35°C with light during 14 hr at the higher temperature. Naked caryopses, placed on absorbent paper moistened with 0.2% KNO_3 solution were used for these tests, which were in duplicate. Weight of seed was determined on: a) complete seed (i.e. caryopsis with lemma and pallea intact and, b) naked caryopses using quadruplicate samples of 100 seeds or caryopses weighed to nearest 0.1 mg.

* The same machine was used here as for the stationary threshing. It was specially designed for experimental work to handle small harvests and with internal construction such as to minimise the retention of seed in the elevators, etc.

TABLE 1

Total yields of pure seed, germination, yields of viable seed and seed weight of Panicum coloratum *obtained by different methods of harvesting*

Method of harvest	Yields of pure seed		Germination %	Yields of viable seed		1000-seed weight g	
	Total kg/ha	Proportion of total Collection (Method 1) %		Total kg/ha	Proportion of total collection (Method 1) %	Complete seeds	Caryopses only
1. Total collection	410 ± 15.2	—	54	221	—	0.977	0.772
2. Cutting and drying in field	317 ± 26.0	77		108	49		
(a) threshed seed	104	25	39	40		0.956	0.777
(b) shed seed	213	52	32	68		0.846	0.767
3. Hand shaking	256 ± 34.9	62	53	136	62	1.030	0.798
4. Reaper and binder	179	44		93	42		
(a) threshed seed	31	8	29	9		0.760	0.668
(b) shed seed	148*	36	57	84		0.794	0.702
5. Direct heading	123	30	35	43	19	0.737	0.673
S.E. of mean						0.014	0.012
L.S.D. P = .001						0.078	0.068

* Portion of this fraction consisted of seed shaken from panicles before they were put through the threshing machine. It was, therefore, not all shed seed in the normal sense.

RESULTS

The gross yields of pure seed, calculated on a per hectare basis are shown in Table 1. Shown also are yields by the different harvesting methods relative to total collection. The same data are presented for viable seed based on the recorded germination.

Of the total collection in method 1 only 21 kg/ha came from the harvest of panicles made after the last collection from slings. Thus 95% of the total yield was shed.

In method 2 cutting of plants either "high" or "low" had no effect on yield, or on the proportion of seed that was shed, so the yields from these two procedures were combined. Of the yield obtained from cutting and drying in the field, 213 kg/ha (67%) was shed but retrieved from the hessian.

With hand shaking the proportion of the total obtained at each collection is shown in Table 2. Some shedding occurred before harvesting commenced so that seed was probably maturing over a period of about three weeks. For the period December 16 to 21, 1970, seed matured at a fairly uniform rate of 21-29 kg/ha/day.

TABLE 2

Seed yield of Panicum coloratum *harvested by shaking ripe seed from panicles at seven different dates and the proportion that each harvest contributed to the total yield*

Date of harvest	Yield at each date—kg/ha	Proportion of total collection—%
Dec. 15	84	33
,, 16	26	10
,, 17	23	9
,, 18	29	11
,, 21	64	25
,, 24	23	9
,, 30	7	3

Method of harvest affected seed size as shown by figures given for 1000-seed weight and the effects were apparent in the weights of the lemma and palea as well as in the caryopses. For complete seed, weights were highest for the harvests that consisted almost entirely of shed seeds (methods 1 and 3) and the difference between these two methods was non-significant. Both gave significantly higher seed weights than all other methods except method 2(a). The weights of caryopses were significantly lower in the three samples mechanically harvested than from the hand harvests.

DISCUSSION

These results demonstrate two characteristics of the seeding of this species which are important in seed harvesting. Firstly, the seed is matured over a long period—well in excess of 15 days—without a peak of maturation (Table 2). Secondly, at the end of this period virtually all seed has been shed. This free-shedding habit is characteristic of the various cultivars of *Panicum maximum* and *P. coloratum* grown in Australia. It has been discussed by Lloyd with reference to *P. coloratum* var. *makarikariensis* (1970).

The 410 kg/ha of seed measured by the use of slings was less than the actual total production. Some shed seed was not retrieved because it fell into the plant bases rather than into the slings and some was probably taken by birds. However, production of about 400 kg/ha from one seed crop of this cultivar can reasonably be taken as a standard for comparison of the efficiency of the different methods of harvesting.

On this basis all methods resulted in considerable seed losses and, if germination after seven month's storage is taken into account the harvesting efficiency, particularly mechanical harvesting, was very low. With direct heading the yield of germinable seed was only 19% of the total collection of pure live seed.

The commercial application of the second method tested, namely cutting and drying in the field would be by mowing, drying in the windrow and then picking up the dried crop with a combine harvester. From the experimental results obtained this method would not be successful in commercial practice because of the large proportion of seed shed during drying. The yield of seed not shed in method 2 amounted to only 104 kg/ha.

The fact that 33% of the seed harvested by hand shaking was collected on the first day indicates that some seed was shed before harvesting commenced. Thus the 62% retrieval by this method is an under-estimate of its efficiency. On theoretical grounds it would be expected to yield more seed than cutting and drying in the field. However, in this comparison of the two methods, although more seed would have been shed before the harvest by cutting and drying was made (because it was done later than the first hand harvest), the single harvest yielded 61 kg/ha more seed than the hand shaking. This suggests there were losses from shedding between hand harvests and some damage to panicles, which further reduced the amount of seed obtained from later harvests. Despite these sources of loss, where labour is plentiful and cheap, careful hand shaking may be regarded as a satisfactory method of harvesting to meet a limited demand. The seed obtained in this manner may be expected to be of high quality.

However, if large amounts of *Panicum* seed are to be harvested by making a number of collections from the same area as the seed matures, a mechanical means of doing so is required. A machine working on the same principle as the buffel grass (*Cenchrus ciliaris*) seed harvester described by Purcell (1969), but with modification, may be satisfactory. This machine consists essentially of beaters which knock the mature seed from the crop into the bin, the same area being harvested several times at short intervals. For it to be successful with *Panicum* the type of beaters used, and their speed, would need to be modified so that the slender panicles were not damaged. The crop would need to be row-sown and the power provided by a high clearance tractor.

The advantage of a method of harvesting that collects ripe seed (i.e. seed ready to shed) is even more apparent when the germinability of the sample is taken into account. In Table 1 only those samples which resulted almost entirely from shedding (Methods 1, 3 and 4(b)) recorded a germination of more then 50%. The shed seed from cutting and drying in the field was anomalous in this regard. Its germination was only 32% compared with 57% for shed seed from the reaper and binder. This latter came from bulky sheaves which dried slowly under cover, whereas the field-dried material was spread thinly on hessian and dried quickly. It is likely that this treatment prevented post-harvest maturation which otherwise might have occurred.

The yield from the reaper and binder was less than half that obtained by use of slings and only 56% of that obtained by cutting and drying in the field. With harvests made on about the same date the yields should have been about the same. The fact that the yield from the reaper and binder was 140 kg/ha less was mainly due to losses from shattering during the passage of the material through the machine and to handling during transport to the drying shed. Despite these losses the yield recorded from the reaper and binder was higher than could be expected in the commercial use of this method. This is so because during the drying on racks of the experimental harvest a high proportion was shed but it was recovered. The proportion shed normally was not as high as indicated in Table 1, as explained in the footnote to this table, but it was estimated at more than 50%. With large areas harvested commercially, drying on racks would not be practicable and if sheaves had to be dried in stooks in the field the seed shed during the drying would be lost.

For a proper assessment of the efficiency of the reaper and binder and direct heading methods of harvesting these should have been done on several dates during the ripening of the crop. It is likely that earlier harvesting with both machines might have given higher yields. Harvesting at several dates had been planned but wet soil conditions prevented the operation of the machines.

Harvesting by direct heading gave the lowest yield and was less than one third of that obtained from total collection. The yield of germinable seed was only 19% of that obtained by total collection. This result would approximate to that expected in commercial operations, any difference being due to the time of the harvest relative to the stage of maturity of the crop and to varying skills of the operators. Despite the low harvested yield this method offers the best prospects for commercial harvesting of *Panicum* with the machinery available at present.

CONCLUSIONS

Reasonable production (more then 400 kg/ha) of seed may be expected from *Panicum coloratum* but harvested yields are well below the potential. This is because the seed crop matures over a considerable period and mature seed sheds readily.

The highest quality seed may be expected when harvested ripe (i.e. close to shedding) or as sheaves which are dried slowly. Rapid drying of sheaves in the field or direct heading produces a sample of low quality. By shaking ripe seed from the panicles or cutting and drying so that shed seed is not lost, from 60 to 80% of the potential gross yield or from 50 to 60% of the yield of viable seed may be retrieved. With the machinery at present available the successful mechanization of these methods is not practicable.

Harvesting with the reaper and binder is only worthwhile if seed shed while sheaves are drying can be retrieved. Even then the yield of viable seed may be as low as 40% of the potential. Direct heading, although it gives only about 30% of the potential gross yield and about 20% of the potential yield of viable seed, offers the best prospects for the commercial harvesting of *Panicum coloratum*, with the machinery available at present.

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