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Crop Management and Seed Harvesting of *Arachis pintoi* Krap. et Greg. *nom. nud.*[1]

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ABSTRACT

Arachis pintoi **Krap. et Greg.** ***nom. nud.*** **is a stoloniferous, perennial legume that is showing promise as a forage and soil conservation ground cover. Conventional peanut harvesting techniques have been inappropriate due to the sward-forming nature of the plant, and asynchronous seed-set.**

This paper describes a successful management procedure for an ***Arachis pintoi*** **seed crop and a method for separating seed from the soil. The crop is grown in sandy soil. During late winter, all top material is removed through grazing and/or mowing, and the area rotary-hoed to a depth of 10 cm. Pods are separated from the soil by sieving. A prototype seed cleaner has been constructed to test a method of separation which will be incorporated into a commercial harvester. The machine comprises two coaxial, counter-rotating cylindrical screens, the outer one retaining the seed and conducting it to a collection receptacle. Yields of about 1 tonne of seed-in-pod ha^{-1} have been obtained.**

Additional index words: **peanut, wild-type** ***Arachis*****, seed set, seed yield, seed harvesting.**

INTRODUCTION

Arachis pintoi Krap. et Greg. *nom. nud.* is indigenous to Brazil, with distribution apparently restricted to the valleys of the Jequitinhonha, Sao Francisco and Tocantins Rivers (C.E. Simpson, Texas A & M University, Stephenville, pers. comm.). This species was initially collected by G.C.P. Pinto in 1954 near the mouth of the Jequitinhonha River (Gregory et al., 1973). This original genotype was introduced into Australia from the USA in 1972 (Anon., 1973). It has been catalogued as PI 338314 in the USA, CPI 58113 in Australia and CIAT 17434 in Colombia. After extensive evaluation, CPI 58113 was released for commercial use in 1987 and will be recommended for registration as cultivar Amarillo by the Queensland and New South Wales Herbage Plant Liaison Committees.

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In the humid sub-tropics of eastern Australia, Amarillo forms a dense sward usually to a depth of 5 to 10 cm, with roots developing at the nodes of the prostrate stems. Like other members of the genus, it is geocarpic, with the fruit mostly a single pod (occasionally a string of two or three) with single seed (rarely two seeds) forming at the end of an oblique gynophore or peg. Pods are concentrated in the top 8 cm of soil (D.S. Loch, QDPI, Gympie, pers. comm.). The sward is maintained by virtue of the species' perenniality together with high seedling recruitment each year. Agronomic evaluation has shown Amarillo to be adapted to a wide range of soil types and to possess a high degree of shade tolerance (B.G. Cook, unpublished). In a grazing trial (Grof, 1985), and in chemical and dry matter digestibility assessments (B.G. Cook, unpublished), Amarillo has proven to be a quality forage. In field plantings, frequently under trees, it is showing promise as a ground cover/soil conservation species.

Other sward-forming *Arachis* wild types set little or no seed and must be propagated vegetatively. Although this can be achieved mechanically (Prine et al., 1981), planting from seed is generally simpler and more acceptable to farmers. Thus, a freely seeding cultivar such as Amarillo has obvious commercial appeal. However, because it is a perennial with a sward-forming growth habit and asynchronous seed set, conventional peanut (*Arachis hypogaea* L.) cultural and harvesting methods are unsuitable. This paper reports a successful crop management system and describes a machine, the principle action of which will be incorporated into the seed cleaning component of a commercial harvester.

BACKGROUND

The reported methods and results have not been derived through experimentation but through a problem-solving exercise. Because seed is set throughout the growing season, it is best to harvest at the end of the growing season to obtain maximum yields. By this stage, pegs on early-set pods have decayed and cannot be lifted from the ground as is done in harvesting commercial peanut crops. It was considered feasible that unattached pods could be extracted from the soil using a sieving process. Initially, flat screens were used for harvesting pods from small plots, but to achieve sufficient screening capacity for a commercial machine, flat screens would be unmanageably large. Rotating cylindrical screens were seen as a more practical alternative. In well structured soils, stable aggregates of comparable size to the Amarillo pod (ca. 6 mm diameter, 11 mm long, 6000 seed-in-pod kg^{-1}) were retained. Seed crops are, therefore, grown in weakly structured sandy soils.

METHODS

Seed Crop Management

Establishment: This section reports establishment of the original 0.25 ha of Amarillo seed crop in south-eastern Queensland which proved successful and formed the basis for subsequent plantings. The site near the coast at 26° latitude receives an average annual rainfall of 1500 mm. The soil, a loamy siliceous sand to a depth of 15 cm overlying a yellow clayey sand, has a surface pH of 5.8 and inherently low fertility.

A dressing of 1 t lime, 500 kg superphosphate, 125 kg muriate of potash, 8 kg copper sulphate, 8 kg zinc sulphate, and 150 g molybdenum trioxide per ha was broadcast prior to planting and incorporated with the final cultivation. Seed was inoculated with *Rhizobium* strain QA 1091 (=CIAT 3101) and sown on 5 November 1985 in rows 65 cm apart approximately 10 cm between seeds within a row at a sowing rate of about 25 kg seed-in-pod ha^{-1}. Weed control was achieved with a variety of herbicide treatments (Table 1). Because the foliage canopy is no more than 5 cm deep at this early stage, rope-wick weed control is effective. Almost complete groundcover was achieved by late March 1986.

Table 1. Herbicide schedule

	Herbicide	Rate (kg ai ha^{-1})[1]	Date applied
Establishment			
pre-emergence	alachlor	2.25	5 Nov. 1985
post-emergence	oryzalin	3.15	23 Dec. 1985
	bentazone	1.44	24 Dec. 1985
	glyphosate	rope-wick	11 Feb. 1986
Subsequent crop			
pre-emergence	alachlor	2.25	29 Sept. 1986
post-emergence	oryzalin	3.15	26 Oct. 1986
	fluazifop	0.4	9 Nov. 1986
Other crop			
post-emergence	glyphosate	0.8	4 Sept. 1986
	2,4-D	1.0	7 Nov. 1986
	sethoxydim[2]	0.4	18 Nov. 1987
		0.4	24 Nov. 1987

[1]applied in 200 l water ha^{-1}, except for glyphosate on 11 February 1986

[2]split application each of 0.4 kg ha^{-1} on the same area

Pre-harvest: In the first and subsequent crops, it was noticed that although flowering commenced 3 to 4 weeks after emergence, few fertile pegs developed initially. Flushes of flowering occurred during the growing season apparently largely in response to improved soil moisture following dry periods. Flowering declined with the onset of cooler conditions in May. Plants became dormant during winter with overnight minimum ground temperatures approaching frost point. Most seed had matured by August.

Post-harvest: Replanting of crop proved unnecessary as the stand regenerated from unrecovered seed and from original plants which developed new crowns on severed tap roots. Weed control in the subsequent crop was successfully carried out according to the schedule in Table 1. Different chemicals have been used in another crop of Amarillo (Table 1). 2,4-D and glyphosate at the listed rates had a slightly deleterious but not long-lasting effect on the peanut, and controlled the target species, *Crotalaria* spp. and *Digitaria didactyla*, respectively.

Seed Harvesting

Preparation: Immediately prior to harvest, all top growth was removed by grazing and mowing. This was necessary to minimize clogging of screens by stem and leaf. The area was then rotary hoed to a depth of 8-10 cm. Rotary hoeing has the dual effect of loosening the soil in preparation for sieving and removing most of the pegs still attached to the pods. Not hoeing would lead to loss of those pods through retention on the coarse screen. Only the area to be harvested in the day should be hoed. Seed starts to germinate overnight in cultivated soil even with fairly low soil moisture. Harvesting commenced on 18 September 1986, a date determined by labor availability and soil moisture once the crop was mature. Soil should be dry or only slightly moist for efficient sieving using the machine described below. Other crops have been harvested up to a month earlier.

Separation and cleaning: The prototype field seed cleaner illustrated in Figure 1 and specifications for which appear in Table 2 has been used successfully in a number of crops.

The prototype machine is self-propelled, the front wheels being driven through a forward-neutral-reverse gearbox. It is steered using a hand-lever attached through a linkage arrangement to the pivoting axle assembly of the rear wheels.

An outer fine-mesh screen with aperture size just sufficient to retain pods, is attached to a cylindrical screen frame with a steel band at each end to act as a track for four nylon support-rollers. These rollers are fitted in pairs on two parallel shafts that are mounted in bearings fixed to the main frame. The shafts are spaced to form a cradle for the screen frame.

Table 2. Field seed cleaner specifications

Frame:	51 x 51 mm rectangular hollow section steel frame.
Wheels:	four 102 x 203 mm two-ply pneumatic-tyred wheels.
Engine:	5 H.P. (at 3600 r.p.m.) horizontal-shaft Briggs and Stratton 4-stroke petrol engine with 6:1 speed reduction.
Screen speed:	23 r.p.m. at 3600 r.p.m. engine speed.
Inner screen:	500 mm diameter x 1400 mm long; 12.7 mm square aperture x 3.15 mm diameter galvanized wire; constructed in one piece and withdrawn axially from frame end plates.
Outer screen:	800 mm diameter x 1220 mm long; 5 mm square aperture x 1.5 mm diameter galvanized wire; constructed in two pieces and split axially.
Slope:	5°, sloping rearwards.
Ground Speed:	28 m $min.^{-1}$ at 3600 r.p.m. engine speed, forward and reverse.

Soil loosened by rotary hoeing is manually shoveled into the opening of the inner coarse-mesh screen which has an aperture size just large enough for pods to pass readily through to the outer screen. Larger particles such as stone and plant material are retained, passing slowly down the length of the screen and dropped behind. The soil lift procedure will be mechanized in developing a commercial harvester. The inner screen of the prototype also supported on four nylon rollers is coaxial with the outer screen but completely independent of it. The rollers are mounted on stub shafts supported in bearings fixed to brackets that are attached to the main frame.

Both outer and inner screen assemblies rotate at the same speed, but in opposite directions, by frictional contact with their respective support rollers. The nylon rollers are driven by a vee-belt and chain drive from the engine. A vee-belt tensioning pulley attached to a hand lever engages the drive.

Two full-length strips of sheet rubber are attached externally to opposite sides of the inner screen frame. These strips act as scrapers that rub against the inside of the outer screen, breaking down small spherical sand aggregates formed by the rotating of the screen. These particles would otherwise be collected with the seed. The scrapers also help remove soil adhering to pods.

The cleaned sample of seed is collected in a sheet-metal box mounted on slides offset between the rear wheels.

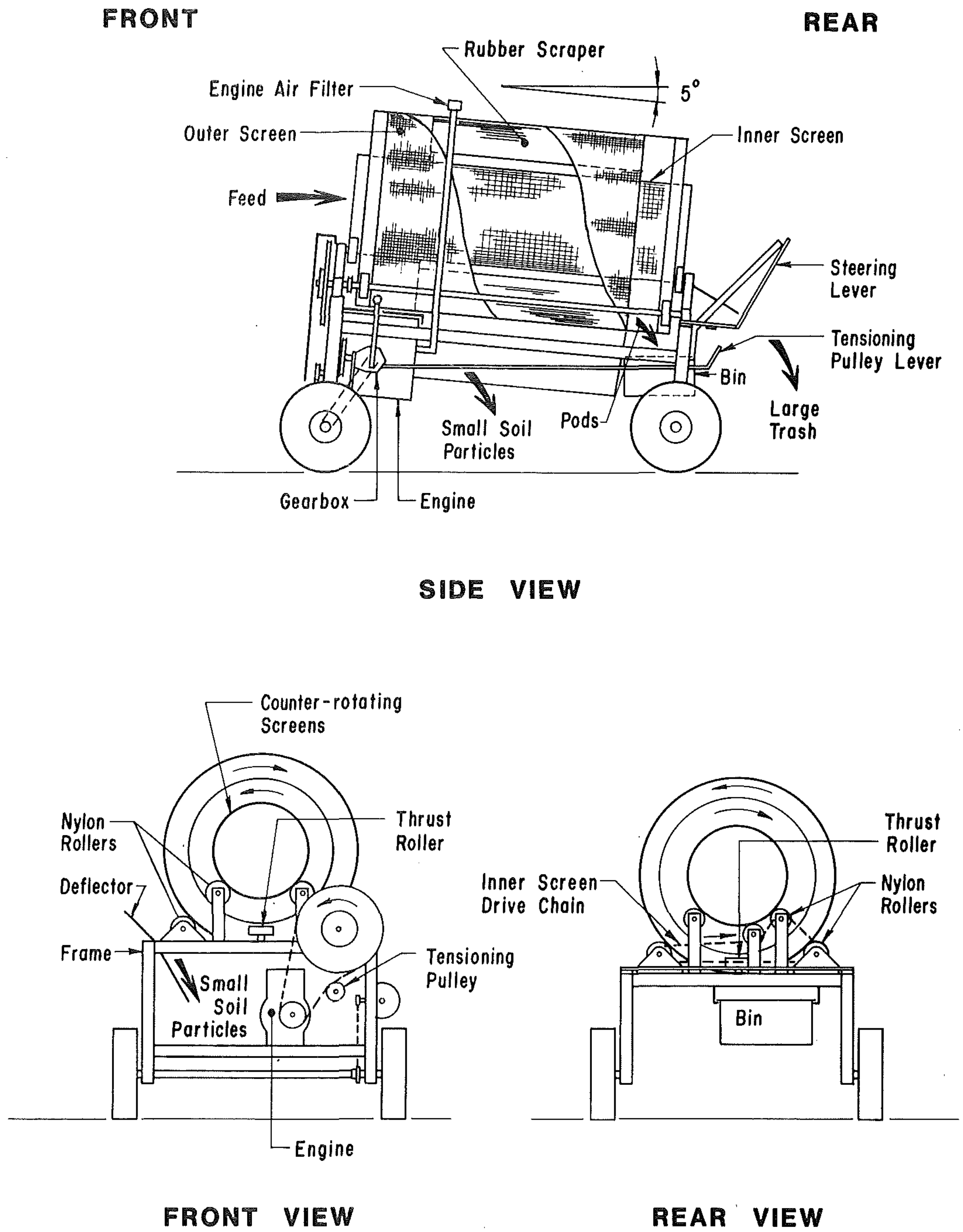

Figure 1. ***Arachis*** **field seed cleaner**

RESULTS AND DISCUSSION

Pod and Seed Yields

First year yields of about 1 t ha^{-1} of clean seed-in-pod or 730 kg ha^{-1} of kernel have been obtained (D.S. Loch, pers. comm.). In a crop where pods were not harvested until the end of the second year, 1.8 t ha^{-1} of seed in pod was obtained. A proportion of the first year crop was lost through germination at the beginning of the second season. Although more work is required to test the proposition, it may be economically more desirable to harvest crops every second year. Even when fully mechanised, the described procedure will be extremely slow (1. to 1.5 ha day^{-1} based on a 1 m width of cut in a machine travelling 2 to 3 km hr^{-1}) and consequently expensive.

Seed Losses

Seed is lost through germination, damage during rotary hoeing and failure of pods to pass through the inner screen. In a 1988 crop where rain interrupted harvest, sampling 1 week after rainfall showed germination losses to be of the order of 5%. Dense seedling populations in other stands of Amarillo in recent years suggest germination losses may be greater than 5% on occasions. A sample collected from the field seed cleaner indicated about 13% of pods had been damaged by the rotary hoe. Although this appears high, there appears to be little alternative to rotary hoeing as a prelude to harvest.

Contaminants

With this harvest system, about 1400 t ha^{-1} of sandy topsoil are processed. In such a quantity, there are always particles of similar size to the seed. Materials most commonly collected with the seed in the bin of the cleaner are peanut stem, charcoal and small stones. Stem is readily removed using conventional seed-cleaning equipment. Stone can be removed using aspiration or the heavy solvent flotation technique (Loch and Butler, 1977). Charcoal which comprised over 50% by weight of some samples is more difficult to remove as it has a density similar to the seed. However, stone and charcoal should be a problem only initially. Once a commercial harvester/cleaner has been developed for this crop, it may be worthwhile to remove potential contaminants using the machine prior to planting.

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