A FIELD EXPERIMENTAL APPROACH TO MAXIMIZING STARCH YIELDS FROM CASSAVA IN INDONESIA

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SUMMARY

By plotting yield of starch per unit of area against crop age for different cultivars, locations and planting dates, curves with maxima are obtained. Although the occurrence of such maxima determines the best moment for harvesting each particular plot, in practice a compromise is made, taking account of harvesting and processing capacity and choosing the length of the working season which is also constrained by other labour demands. Obtaining data by the method described provides a guide for the effective organization of harvesting and processing operations.

RESUME

En comparant le rendement en amidon par unité de surface avec l'âge de la plante pour les différents cultivars, lieux et dates de semis, on obtient les extrêmes des courbes. Bien que les extrêmes représentent la meilleure période pour la récolte de chaque parcelle, dans la pratique, on adopte une voie moyenne en prenant en compte la capacité de récolte et de transformation d'une part, et en choisissant la durée de la saison de travail qui est par ailleurs soumise aux demandes de main-d'ouvre dans d'autres secteurs. La détermination des données par ce procédé permet une organisation plus adéquate de la récolte et des opérations de transformation.

RESUMEN

Se obtuvieron curvas con máximo al graficar rendimiento de almidón por unidad de área contra: edad de cultivo para diferentes cultivares, localidad y fecha de siembra. Si bien que la ocurrencia de esos máximos determina el mejor momento para cosechar cada lote particular, en la práctica se hace un compromiso tomando en cuenta la capacidad de cosecha, procesamiento y seleccionando la duración de la temporada de trabajo, la que también se encuentra restringida por otras demandas referentes a la mano de obra. La obtención de datos por el método que se describe provee una guía para la organización efectiva de la cosecha y el procesamiento de operaciones.

INTRODUCTION

Knowledge of factors determining starch accumulation in the roots is of value when cassava is grown for the purpose of starch production in order to optimise the time of harvesting for this purpose. Well organized cooperation between plantations and the factory allowed maximum production of the end product at a high standard quality.

Before World War II, Amsterdam Ltd. (H.V.A.) produced 55-60 thousand tons of cassava starch in Indonesia and was one of the largest producers. Cassava crops were grown on five plantations in rotation with sisal, sugarcane and leguminous crops, and much care was taken to maintain conditions ensuring high yields of all crops grown. Recently renewed interest and a favourable political climate may lead to reconsideration of the economic possibilities of this kind of enterprise.

REVIEW

Cultivar effects

Not only do the different cultivars produce highly differing total production of roots and starch within a certain period of time, but they may also vary in growth rate and development.

Fertility effects

When grown under conditions favouring the production of high root-yields, the rate of starch accumulation is often lower in comparison with that in a crop growing under less favourable conditions. On the other hand, excessive development of aerial parts of the plant, promoted by unbalanced nutrient supply is associated with low accumulation of starch in the roots.

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Climatic effects

Temperature

Dulong[2] showed that starch accumulation is favoured by cool weather conditions. This observation supported the findings of Tourneur[3] that a crop grown at high altitude is richer in starch as compared with a lowland crop. When grown under conditions of relatively high altitudes, cassava often flowers.

Light intensity

In Indonesia shading cassava invariably leads to losses in yield. Seasons of unusually prolonged rains are usually associated with reduced rate of accumulation of starch in the roots and reduced root yields of the fields harvested in the early part of the working season. According to Bolhuis[1], a day length of about twelve hours is optimal for the development of cassava. The increase in leaf area index (LAI) with reduced light intensity which has been found by Williams and Ghazali[4] is not sufficient to maintain an unchanged level of accumulation of starch in the root systems of shaded plants.

Precipitation

Effects of prolonged rainfall are confounded with a decrease in the number of sunshine hours and no data clearly attributable to precipitation are available. However, early rains at the end of the dry season may lead to new growth of the aerial parts of the plant accompanied by a sharp drop in the stored starch content of the roots.

ENVIRONMENT, MATERIALS AND METHODS

Environment

Data in this paper have been obtained from Eastern Java (Indonesia). Fig. 1 gives the range of climatic conditions in this area. The total annual rainfall amounts to about 2,000mm (80 inches) and there is a distinct dry season of about four to five months (June to October). The planting period of cassava starts after the first rains (December) and ends in March-April. The length of the working period is limited by the start of the wet monsoon because at that time the planting of paddy requires much attention, rice being the most important subsistence crop. The remaining labour is needed for land cultivation, planting or the new cassava crop and sowing the leguminous crops for green manure.

Materials

Two cultivars were used, 'Singapore', a sweet cultivar and 'ISPP, a bitter cassava.

Methods – Field experiments

Each experiment consisted of two cultivar treatments, with six replications, Each plot contained 22 x 31 = 682 plants, and the harvest comprised 15 samples of 20 plants from every second row (thus omitting border rows and end plants), leaving one standing row between each sample row. The sampling usually started in September (at the crop age of 6-9 months) and ended in November of the following year. In each category of the crop (plantation, cultivar, month of planting etc.) a number of such experiments was undertaken each year.

RESULTS

Fig. 2 illustrates graphically the mean results of a number of these experiments of the same year, carried out with the sweet cultivar 'Singapore'. For ease of comparison all data are calculated as percentages of the maximum. Smooth curves are drawn fitting the measured data. The yield of roots shows a slight but steady increase up to the age of about 19-20 months (Fig. 2). In contrast, the starch content reaches its maximum after only 16-18 months. When the results are compiled over a number of years, the lines of Fig. 3 and 4 are obtained, showing the course of the 'starch-yield-curves' in four different plantations and for the two cultivars. In three of the four plantations there is no great difference in the position of the maxima between the experimental results of one (cultivar/date of planting) category. Cassava planted in December reaches its optimum yield in the months May-June (18-19 months). However, on the Galuhan

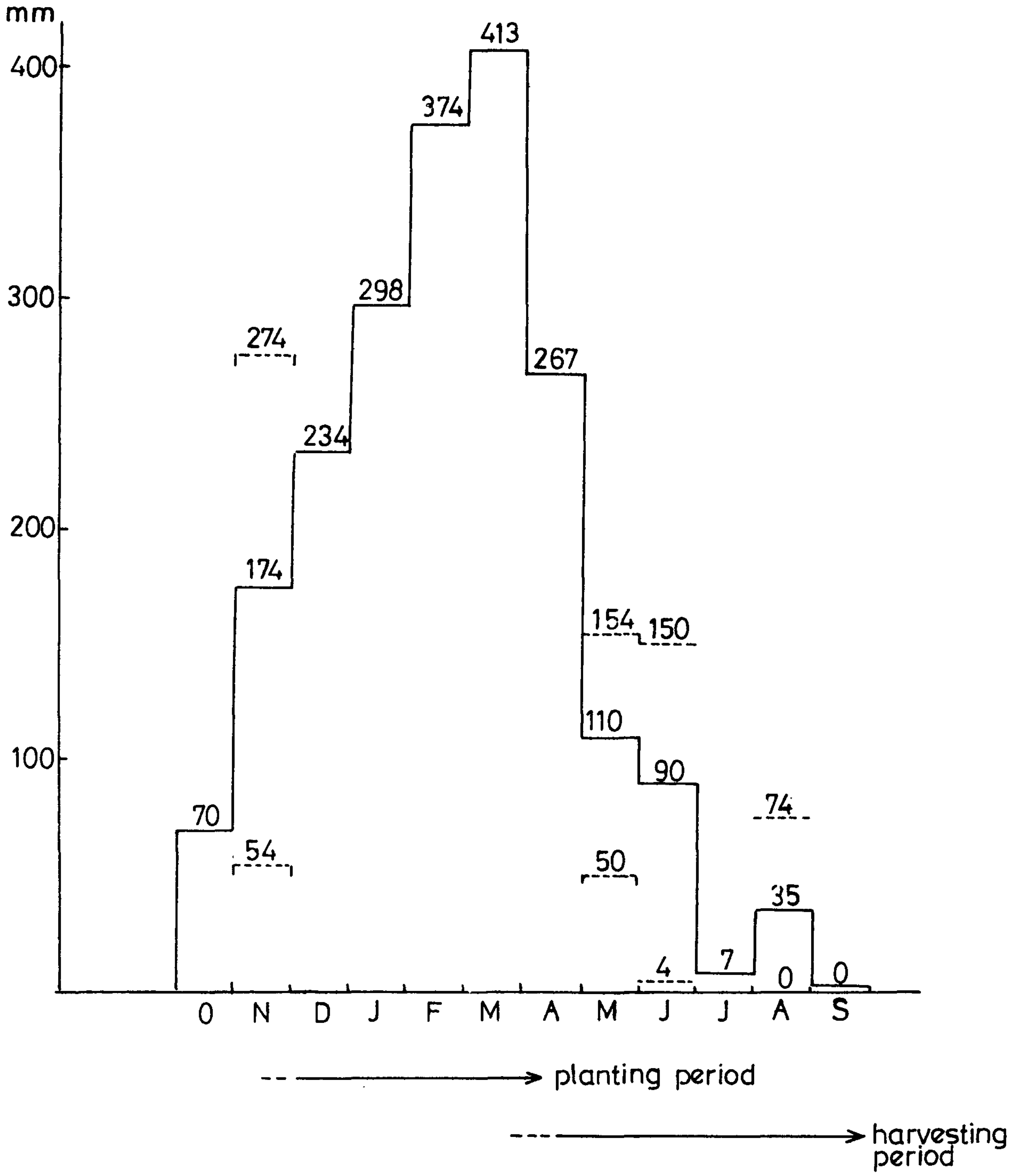


Fig. 1. Mean rainfall Karang Dinoio plantation (East Java).

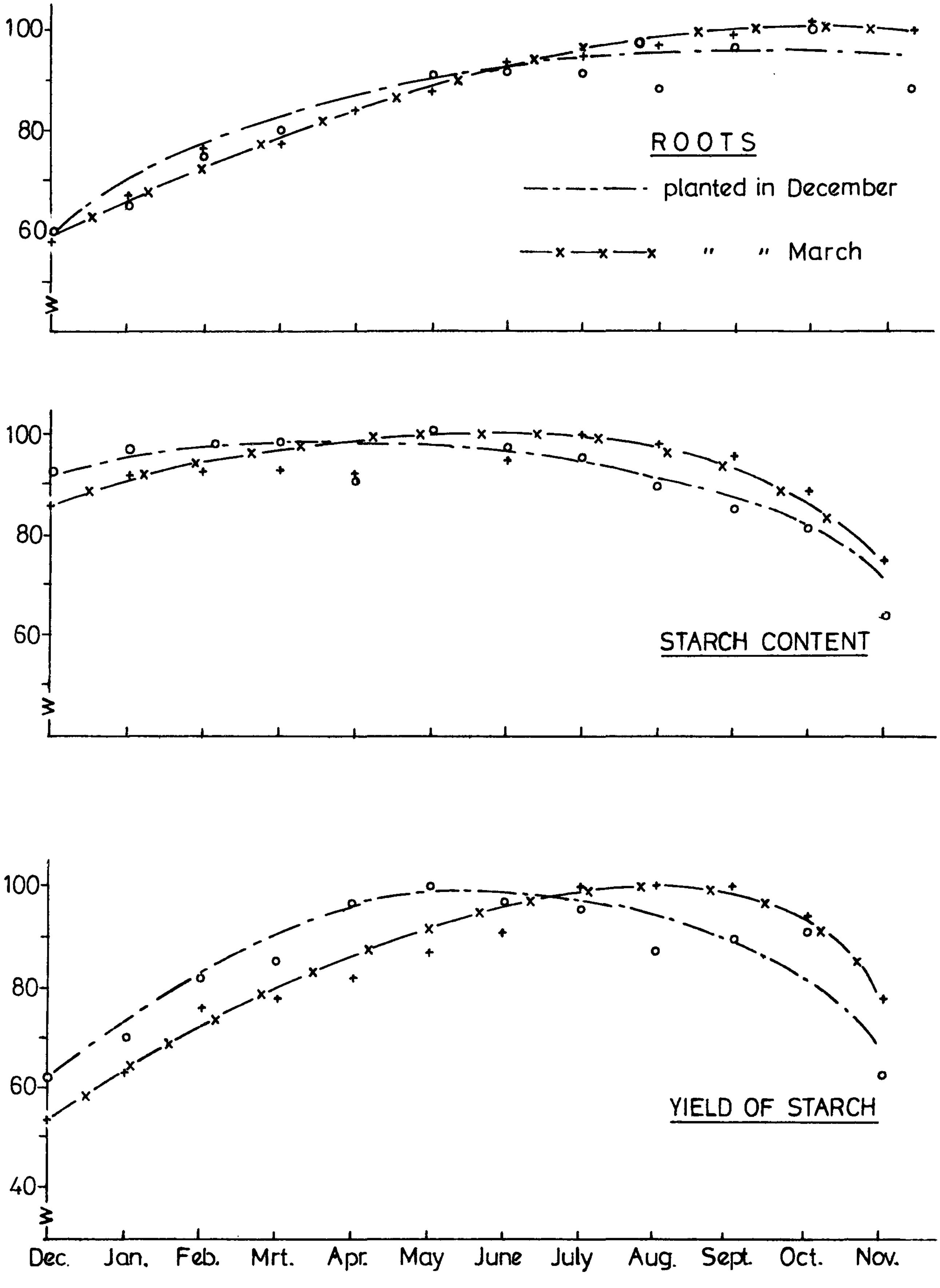
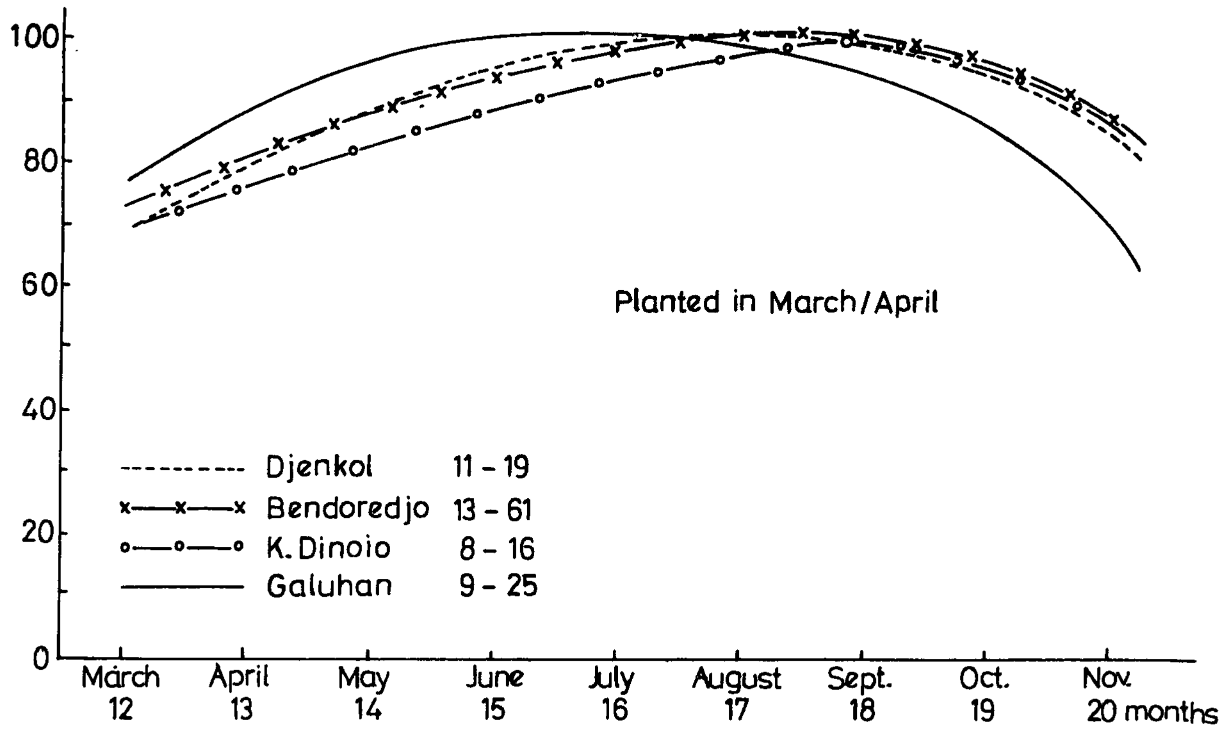


Fig.2 Results of two periodically harvested field experiments with two different planting dates. (Results calculated as percentage of optimum) Cultivar Singapore.



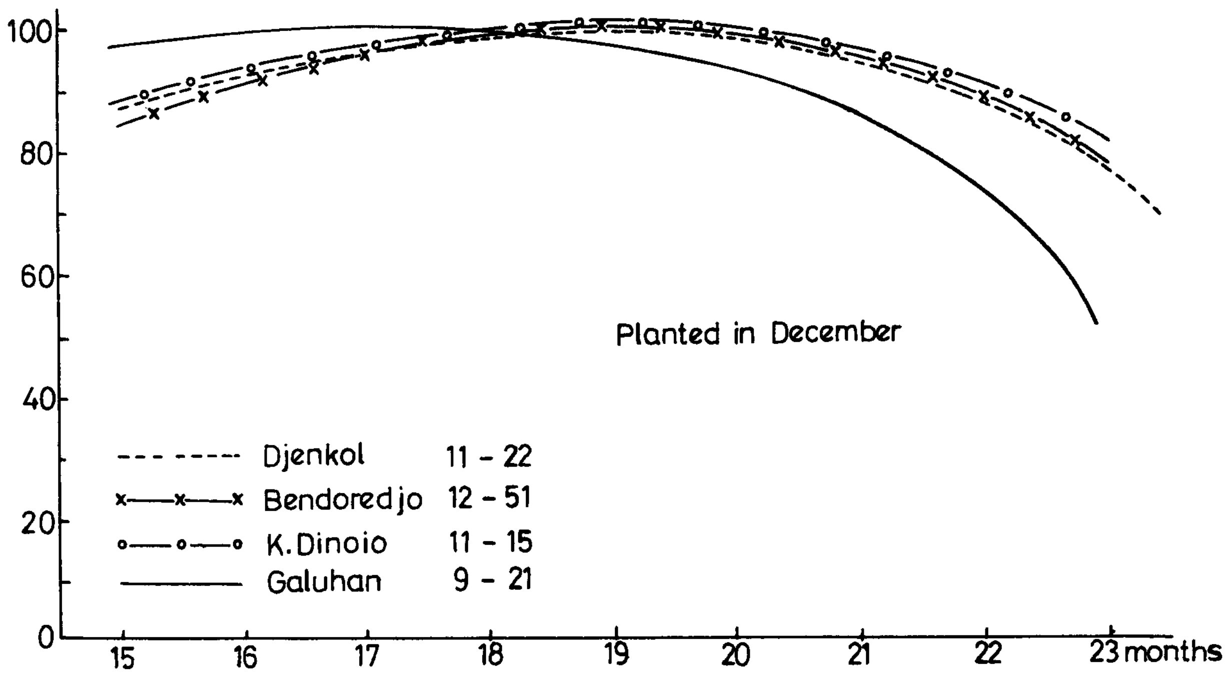
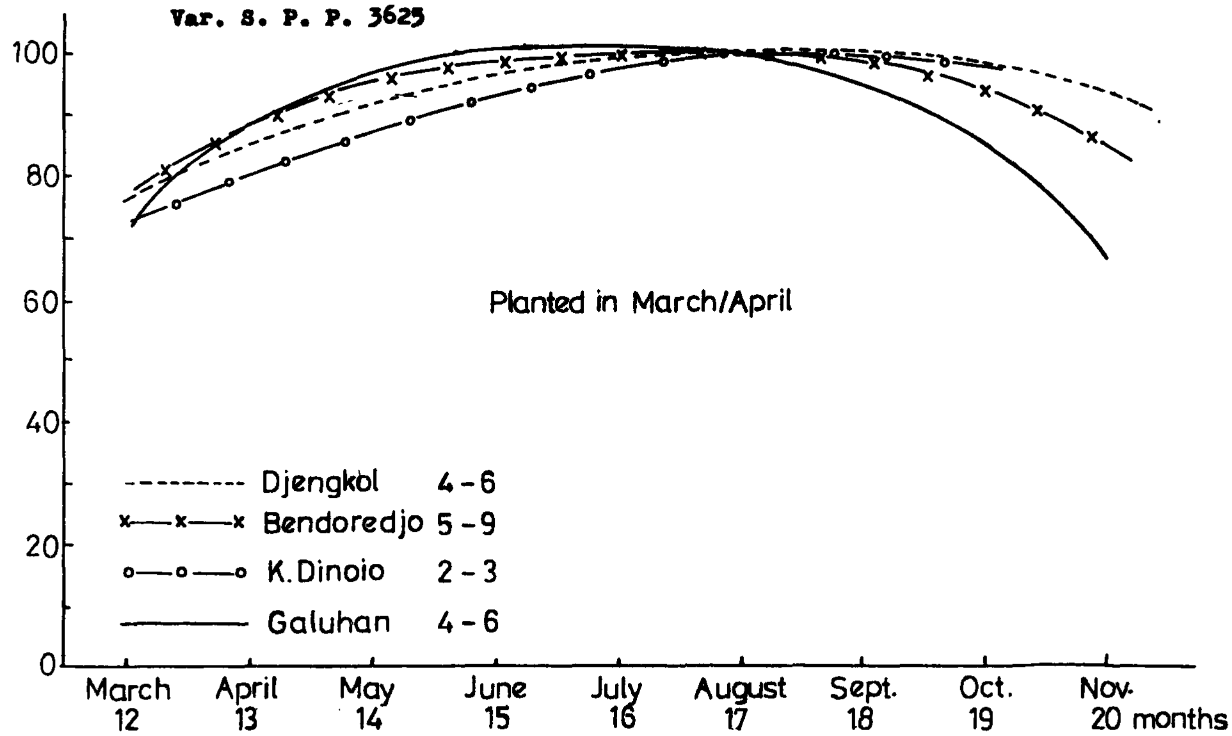


Fig. 3 Mean starch yields expressed as percentages of optimum yield (Data from four plantations; first figure = number of years, second figure = number of experiments). Cultivar Singapore.



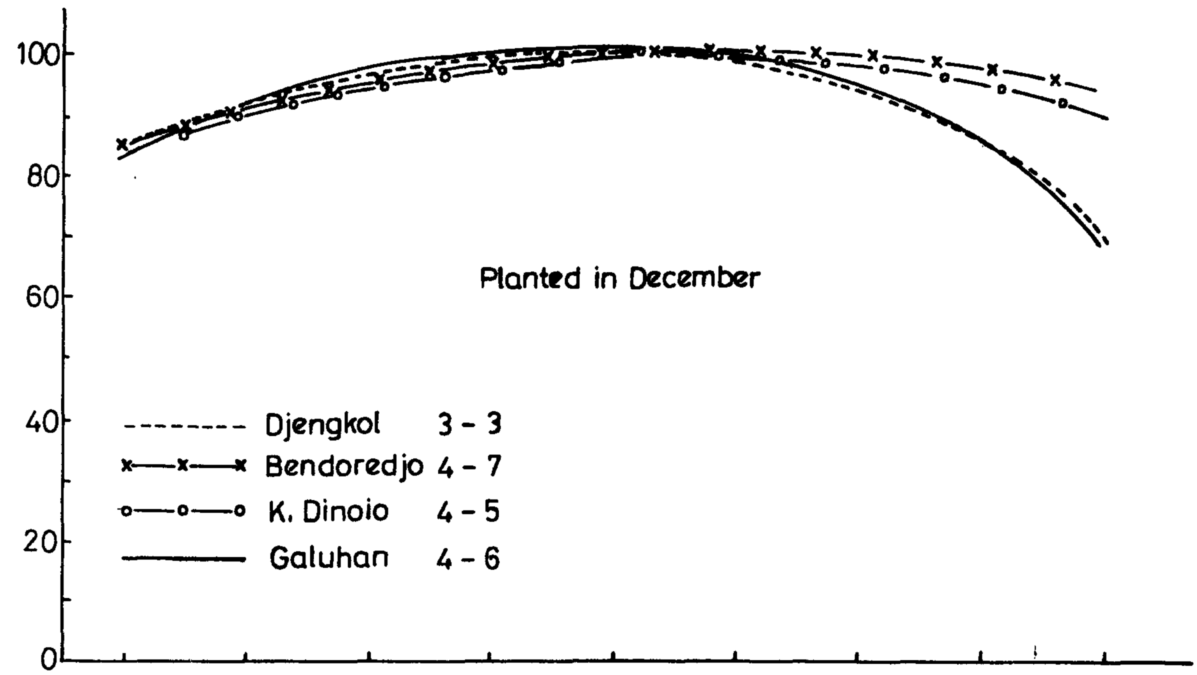


Fig. 4 Mean starch yields expressed as percentages of optimum yield (Data from four plantations; first figure = number of years; second figure = number of experiments) Cultivar S.P.P.3625.

plantation, the optimum is reached after 15-16 months, and is followed by a steady decline. The curves of the plantings of February-March reach the optimum value in August-September and tend to show more variation between the different plantations. Here also the behaviour of cassava on the Galuhan plantation is anomalous.

DISCUSSION

The observed differences between the different categories of the crop in starch accumulation make possible adjustments to the sequence of harvesting to approach maximum yields. When setting up the processing operation, the number of days necessary for the processing of each category (cultivar at one planting date) is calculated on the basis of the size of its area, the yield estimates of each plantation, and the capacity of the factory. This fixes the total length of the working period of the processing plant. The use of the starch-yield progress curves make it possible to calculate what amount of starch is lost when any particular category is harvested earlier or later than the optimal month (for this purpose the actually calculated losses are expressed in tons and not in relative values.) Hence one can determine the date of starting the processing operation which will minimize the total losses.

APPLICATION OF THE SYSTEM

This system of working proved efficient in spite of limitations caused by the following:

1. The starch-yield progress curves were constructed on the basis of average figures over several years. The annual deviations from the average figures could be considerable, especially when weather conditions at the end of the growing period differ from the 'normal' conditions. However, the climate of the region was rather steady, and the observed annual deviations in yields in most plantations were usually not great enough to affect the best course of processing that had been planned.
2. In practice it was not always possible to follow strictly the precalculated system of harvesting. Sometimes the fixed system of crop rotation requires changes in the working scheme. It may also be possible that requirements of the processing plant will call for alterations in the sequence of harvesting with regard to the quality of the final product.

To evaluate the practical usefulness of the experimental work, schedules based on production using the average production curves were checked several times at the end of the year when the scheme that would have been best in that particular season could be determined. It was found that for the cultivars 'Singapore' and 'SPP' amounts of starch corresponding to 95 and 98 percent respectively of the maximum production could be actually recovered.

The study of the rate of accumulation of starch is clearly important in the evaluation of different cultivars.

Attempts to adjust the processing operation in any one particular year by using the field experimental results of the same season are not very promising, and the use of average figures over several years provides an effective alternative basis for planning.

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