The Mukibat System of Cassava Production

T. S. Dharmaputra and G. H. de Bruijn[1]

The Mukibat system may outyield normal cassava production systems. Individual varieties react differently to the system, therefore it may be possible to select for high yielding varieties that have good eating quality, but which only produce moderately under the normal system.

The highest accumulation of dry matter in the root of the Mukibat cassava occurred between 12 and 15 months in all three varieties tested (it was not necessary to make planting holes for the Mukibat system). Nitrogen was the limiting plant nutrient at one location.

Scion material taken from the Mukibat plants was found to be as good as that taken from the original *M. glaziovii* tree. Two different types of scion were tested: the so called "black" type was superior to the "white" type at one location, but not at the other.

The Mukibat system is based on the grafting of *Manihot glaziovii* on a stock of *M. esculenta.* With this system, higher yields are obtained, and, especially in East Java, the practice is steadily expanding, mostly for homeyard production. Research is necessary to get more information about the possibilities of improving the Mukibat system, which has already been adopted by so many farmers. Some preliminary results from the first and the second year's experiments at Brawijaya University are presented here.

Experiments

Preparation of Planting Material

Mukibat grafts were prepared by the splice grafting system. A 15-cm piece of stem of *M. glaziovii*, serving as a scion, was grafted on to a 25-cm stock of *M. esculenta.* The diameters of both scion and stock were between 20 and 30 mm. A thin piece of bamboo was put in the pith of both scion and stock to strengthen the union of the graft. Raffia fibres were used as binding material, but later it was found that a more elastic binding material or natural fibres such as banana leaf stalk fibres were better. The grafts were placed upside down for 5 days, and then put in a nursery under shade. The grafts that sprouted well were used in the experiments. For the normal system of planting, 30-cm cuttings (20–30 mm diameter) were used.

[1]Department of Soil Science, Faculty of Agriculture, Brawijaya University, Malang, Indonesia, and Department of Tropical Crop Science, Agricultural University, Wageningen, The Netherlands, respectively.

Planting

For the Mukibat system in the first year's experiments (1973/1974) planting holes ($1 \times 1 \times 0.3$ m) were made in most cases. In each hole, 20 kg of partly decomposed organic matter from market waste was mixed with soil. In the second year's experiments (1974/1976) planting holes and organic matter were not used.

The stakes were planted in a vertical position. For the Mukibat system, except in the plant density experiment, the spacing was 2×2 m in the first year's experiments, 1.5×1.5 m in the second year's experiments. For the normal system the spacing was 1×1 m. Planting was at the beginning of the rainy seasons.

Growth Period

For the Mukibat system in 1973/1974, except for the growth period experiment, harvesting occurred after 12 months; in 1974/1976 the growth period was 15 months. For the normal system, a 10 month growth period was used.

Effect of the Mukibat System on Yield

Experiments were carried out to compare the yield of local and improved varieties with the normal and the Mukibat system. Three locations were chosen for the 1973/1974 variety experiments and four locations for the 1974/1976 experiments. For 1974/1976 variety experiments data are available from only three locations. Mukibat and normal cassava experiments were carried out separately. In 1974/1976, an additional experiment was carried out at Muneng to compare yields obtained after different growth periods, both for the Mukibat and the normal system. Yields after

Table 1. Root yield (dry matter, t/ha, total and per month) of different varieties of the normal cassava (growth period 10 months) and of the Mukibat cassava (growth period 12 months) at three locations in the 1973/1974 experiments.

		Total yield		Yield per month	
Location	Variety	Normal	Mukibat	Normal	Mukibat
Pagak	Faroka	11.1	10.5	1.11	0.88
	Muneng 257	10.0	8.0	1.00	0.67
	Ketan	9.9	9.0	9.99	0.75
	Somo	9.0	9.5	0.90	0.79
	Ngganing	8.5	9.4	0.85	0.78
	Mentega	8.2	8.6	0.82	0.72
	Ambon	7.9	7.5	0.79	0.63
	Ndoro	7.9	6.7	0.79	0.56
	Average	9.1	8.7	0.91	0.72
	C.V. (%)	38	38		
Muneng	Muara	6.2	5.4	0.62	0.45
	259-D-Gm-42	5.4	5.4	0.54	0.45
	Pandesi	5.2	7.0	0.52	0.58
	Faroka	5.0	7.0	0.50	0.58
	Gading	4.9	5.9	0.49	0.49
	Ambon	4.4	6.4	0.44	0.53
	Ngganing	4.2	6.9	0.42	0.58
	260-E-Am-7	3.9	4.3	0.39	0.36
	Average	4.9	6.0	0.49	0.50
	C.V. (%)	38	37		
Lumajang	Faroka	12.3	13.6	1.23	1.13
	Muara	9.9	7.9	0.99	0.66
	257/B/Va	9.1	11.8	0.91	0.98
	Valenca	8.7	10.6	0.87	0.88
	Ndoro	8.6	13.2	0.86	1.10
	Ngganing	8.5	11.5	0.85	0.96
	Mentega	7.6	9.4	0.76	0.78
	Genjah Putih	6.6	9.4	0.66	0.78
	Average	8.9	10.9	0.89	0.91
	C.V. (%)	36	36		

growth periods of 10 and 12 months are available. The 1973/1974 data are shown in Table 1; the 1974/1976 data in Table 2.

The Mukibat system did not reduce the overall yield variation among the tested varieties. The coefficients of variation for both Mukibat and normal cassava at all locations were similar. However, the effect of the Mukibat system on the yield of individual varieties was not the same. High yielding varieties may not necessarily be high yielding when planted as Mukibat. The reverse is also true. Some varieties, like Ndoro and Mentega, responded better to the Mukibat system than other varieties. These are low yielding varieties that are preferred because of their good eating quality.

Yield per month was calculated for both normal and Mukibat cassava to provide an indirect comparison of the productivity of both systems. There is an indication that in the 1974/1976 season the yield per month of the Mukibat cassava is much higher than that of the normal cassava. In the 1973/1974 season the Mukibat system did not produce more, and at Pagak even less, than the normal system. This unexpected result may be due to two reasons. First, the spacing, 2 × 2 m, in the Mukibat system was too wide to allow optimal production. Second, preparation of planting material and planting of grafts was delayed by almost 2 months, which, according to farmers' experience, can reduce the yield of Mukibat plants considerably.

The results of the 1974/1976 variety experiments thus provide an indication that the

Table 2. Root yield (dry matter, t/ha, total and per month) of different varieties of the normal cassava (growth period 10 months) and of the Mukibat cassava (growth period 15 months) at three locations in the 1974/1976 experiments.

Location	Variety	Total yield		Yield per month	
		Normal	Mukibat	Normal	Mukibat
Tulungagung	Faroka 2	4.3	9.2	0.43	0.61
	Mentega	4.1	6.0	0.41	0.40
	Manggler	3.3	7.8	0.33	0.52
	Pandesi	3.3	8.3	0.33	0.55
	Caparoka	3.2	3.9	0.32	0.26
	Ndoro	1.7	7.6	0.17	0.51
	Average	3.32	7.13	0.33	0.48
	C.V. (%)	28	27		
Pagak	Pandesi	6.3	13.6	0.63	0.91
	Faroka 2	5.8	13.7	0.58	0.91
	Ndoro	5.4	12.6	0.54	0.84
	Faroka 1	5.1	11.1	0.51	0.74
	Raung	4.6	9.1	0.46	0.61
	Markati	3.4	10.8	0.34	0.72
	Average	5.1	11.82	0.51	0.79
	C.V. (%)	20	15		
Lumajang	Faroka 2	6.1	15.0	0.61	1.00
	Muara	5.8	15.8	0.58	1.05
	Valenca	5.1	12.7	0.51	0.85
	Ndoro	4.7	17.6	0.47	1.17
	Mentega	4.6	16.6	0.46	1.11
	257/B/Va	4.4	18.2	0.44	1.21
	Average	5.12	15.98	0.51	1.06
	C.V. (%)	14	12		

Mukibat system gives a higher root yield than the normal system, and these results correspond to farmers' experience of many years. The results of the experiments in which yields are compared after different growth periods support the indication that the yield potential of the Mukibat system is better than that of the normal cassava. The yields of three varieties (Faroka, Pandesi, and Ndoro) grown at Muneng, at two growth periods (10 and 12 months), were consistently higher with the Mukibat system. Experimentation is continuing.

Influence of the Planting Holes on Yield

Two experiments were carried out at two locations in 1973/1974 to evaluate the effect of planting holes for the Mukibat system. Under the Mukibat system, farmers often dig planting holes into which they put organic matter from the garden or kitchen. After filling the holes with soil mixed with the organic matter, the grafted cuttings are planted on top.

The treatments in the experiments were: (1) hoeing instead of hole; (2) hole 1 × 1 × 0.3 m; and (3) hole 1 × 1 × 0.5 m. They were arranged in subplots in a split-plot experiment, the main treatments being the varieties. Compost (50 t/ha) was mixed with the soil in the holes or while hoeing.

There was no beneficial effect of the holes on the yield, and the holes even significantly decreased the yield at Pagak. This suggests that making holes as one of the land preparations as done by some farmers may not be necessary. The practice of digging holes has been abandoned by farmers in regions where drainage of the land is poor. They usually plant on hills or ridges.

Relation Between Length of Growth Period and Yield

The relationship between the length of the growth period and the yield of the Mukibat cassava is one of the important factors deter-

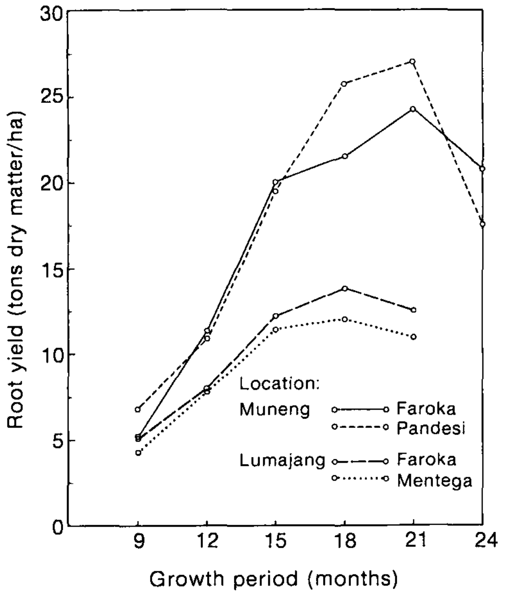

Fig. 1. Relationship between the length of growth period and yield of Mukibat cassava for three varieties at Muneng and Lumajang.

mining the optimum time for harvest. One experiment was carried out at each of two locations, Muneng and Lumajang, with two varieties per location. Planting was done at the beginning of the rainy season, December 1973, whereas at Lumajang replanting had to be done in February 1974 because of serious wind damage. Replanting reduced the number of replications. The material for replanting was obtained by cutting the stem above and below the union of the graft of the remaining plants. This replanting technique is common among the local farmers. Harvesting took place 9, 12, 15, 18, 21, and 24 months after planting or replanting. Results of dry matter root yield are presented in Fig. 1.

The highest accumulation of dry matter in the roots was obtained between 12 and 15 months with an average of 2.9 and 1.3 t/ha for the tested varieties at Muneng and Lumajang, respectively. A decrease in yield was obtained after 21 months (Muneng) and 18 months (Lumajang). This period coincided with the beginning of the rainy season, which started in early September in 1975. A lot of roots were rotten and consequently resulted in loss of yield. Harvest beyond 21 months at Lumajang was not possible because many trees had fallen and were rotten. For both Muneng and Lumajang, the growth period could extend to 18 months. Harvesting after a shorter growth period would be necessary if root quality began to decrease earlier. Data on the development of root quality during the growth period are not yet available.

Yield of Mukibat Cassava Using Different Kinds of Scion

Original Versus Nonoriginal *M. glaziovii* Material

Some farmers assume that the scion material should be taken from original *M. glaziovii* plants and not from the Mukibat plants (nonoriginal). Experiments were carried out to compare the yield of Mukibat plants with scion derived from the original *M. glaziovii* tree with plants having scion derived from Mukibat plants at two locations in the 1973/1974 season.

At both locations there was no significant difference between the yield of Mukibat plants related to whether the scion derived from original or nonoriginal *M. glaziovii* material. This suggests that a scion taken from a Mukibat plant will be as good as that taken from the original *M. glaziovii* tree.

"Black" Versus "White" Scion Material

Under the Mukibat system, farmers use more than one type of scion material. Most common is the so-called "black" type. Another type is called the "white" one. This one has a light coloured stem bark and the shape of the plant and its leaves is different from the "black" type, which has a dark green coloured stem bark.

At two locations, the yield of Mukibat plants derived from "black" scion material was compared to that of plants from "white" scions. The design was a split plot. Varieties were arranged in the main plots and the scion types were put in the subplots. At Pagak the root yield of the "black" type was superior to that of the "white" one, which corresponds to the experience of a majority of farmers. But at Lumajang no difference was found between the two types. Further research is still needed on this subject, and a botanical identification will be carried out to determine whether both types are *M. glaziovii.*

Effects of N, P, and K on Yield

The use of fertilizers for cassava production in Indonesia is still very limited. Some farmers apply a small amount of urea, once or twice during the growth period (De Bruijn and Dharmaputra 1974).

To study the need of fertilizers for Mukibat cassava NPK experiments were carried out at two locations in East Java in 1974/1976. Only data from one of the locations, Tulungagung, are available. The chemical properties of the soil are as follows: pH $= 6.1$, organic-C $=$ 0.55%, total-N $= 0.04\%$, 0.03 N NH_4F and 0.01 N HCl extractable P $= 120$ ppm, and N NH_4-acetate extractable K $= 66$ ppm.

A split plot experiment was used. There were two varieties, Faroka and Ndoro, which constituted the main plots, while the combinations of N, P, and K fertilizers were arranged factorially in the subplots. P as TSP was applied 15 days after planting, N as urea and K as potassium sulfate were applied in equal split application 15 days and 4 months after planting, respectively.

The only significant effect was the N treatment. On average the application of urea equivalent to 100 kg N/ha resulted in twice the yield of the no N treatment. Further increase of the N rate did not significantly increase the yield.

Discussion

The fact that an increasing number of farmers are adopting the Mukibat system is a strong indication that the system is superior to the normal cassava production system. The preliminary results of the experiments also indicate that the yield of the Mukibat cassava is higher than that of the normal cassava if Mukibat cassava is planted at the right time with proper plant spacing.

Because the response of individual varieties to the Mukibat system varies considerably, the possibility exists of selecting for high yield within varieties that have good eating quality but only produce moderately under the normal system. This is very attractive in Indonesia where almost all cassava is used for human consumption.

The conclusion that making planting holes is not necessary has an important practical implication because labour input for the system can be reduced. This means that the system may be practical for larger fields. Another practical conclusion is that special *M. glaziovii* plantings for obtaining scion material may not be necessary, as the scions taken from the Mukibat plants proved to be as good as those taken from the original *M. glaziovii* tree. However, it is still not known whether scion material repeatedly taken from Mukibat plants without renewal from the original *M. glaziovii* trees will be effective. Further research is needed on this point.

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Undersowing Cassava with Stylo Grown Under Coconut

I. M. Nitis and M. Suarna[1]

Three field experiments on undersowing cassava with stylo were carried out in Bali. Stylo drilled under the cassava at diagonal crossing produced tuber dry matter (D.M.) similar to that of cassava sown without stylo. Other methods of sowing stylo (broadcast, windrow, crisscross, and drill midway between the 2 cassava) significantly ($p = 0.05$) decreased the tuber D.M. yield by 32–51%. Windrow sowing the stylo under the cassava by replacing cassava with stylo so that the spacing increased from 40 $\times$ 40 cm

[1]Department of Nutrition and Pasture Agronomy, F.K.H.P., Udayana University, Denpasar, Bali, Indonesia.