The Background Skin Colour of Exported Mango Fruit in Relation to Tree Nitrogen Status

C.B. McKenzie
Merensky Technological Services, P.O. Box 14, Duivelskloof 0835

ABSTRACT

Mango fruit colour and post-harvest keeping quality are critical in maintaining and expanding South Africa's export market share. Market agents can no longer deal with fruit that will not de-green. There may be many reasons for poorly coloured, low quality fruit, but nutritional status of the tree and fruit probably plays a major role. Fruit arriving on the European markets were sampled during the 1992/93 and 1993/94 seasons for quality inspections. Background skin colour was classified and rated. The ratings showed that some growers consistently produced desirable yellow fruit while others produced fruit that would not de-green. A third group fell between the two extremes. In addition, development of colour was most closely related to cultivar. Cultivars such as Tommy Atkins and Heidi adequately de-greened, while Keitt and Kent generally did not. A survey of grower nutritional practices showed that orchards with a higher N-status tended to produce green fruit, and those with lower N-status usually resulted in the production of yellow fruit. Many growers also cited picking time with respect to fruit maturity as an important factor. N leaf norms are traditionally based on yield with little or no regard to colour and quality, particularly in view of early picking and extended cold transit. Adjustments to these norms, as well as to the timing and type of N fertilization are recommended.

UITTREKSEL

Mango vrugkleur en na-oes houvermoë is 'n kritiese faktor in die handhawing en uitbreiding van Suid Afrika se uitvoer markaandeel. Markagente kan nie meer vrugte hanteer wat nie verkleur nie. Daar kan verskeie redes wees vir swak gekleurde, lae kwaliteit vrugte, maar die voedingstatus van die boom en vrugte speel waarskynlik die belangrikste rol. Monsters is geneem van vrugte wat gedurende die 1992/93 en 1993/94 seisoene uitgevoer is vir kwaliteits inspeksies. Agtergrond skilkleur is gekwantifiseer en geëvalueer. Die evaluasies het getoon dat sekere kwekers konstant mooi geel vrugte produseer terwyl ander weer vrugte produseer wat nie 'n geel kleur ontwikkel nie. 'n Derde groep is ook geïdentifiseer wat tussen die twee uiterstes val. Tesame hiermee is gevind dat kleurontwikkeling naby verwant is aan spesifieke kultivars. Kultivars soos Tommy Atkins en Heidi het genoegsaam ontgroen terwyl kultivars soos Keitt en Kent oor die algemeen nie ontgroen het nie. 'n Oorsig van kweker bemestings praktyke het getoon dat boorde met 'n hoë N-status groen vrugte lewer en boorde met 'n laer N-status goed gekleurde vrugte lewer. Baie kwekers het ook pluktyd met spesifieke verwysing na vrugvolwassenheid as 'n belangrike faktor beskou. N blaarnorme word tradisioneel gebaseer op opbrengs en nie op vrugkleur en kwalitiet nie, veral met die oog op vroeë pluk en uitgerekte koelvervoer. Aanpassings van hierdie norme, asook die tyd en tipe N-bemesting word aanbeveel.

INTRODUCTION

Mango fruit colour and post-harvest keeping quality are critical in maintaining and expanding South Africa's export market share. South African fruit is picked early, while still green, as it must undergo extended cold road and sea transit before reaching Europe. In recent years inadequate de-greening either during transit, or after removal from cold storage has been a major problem on the European markets. This fruit is often perceived as being immature. While picking maturity is known to play an important role, it does not explain why fruit of similar maturity stored at the same temperatures, colour up differently.

Oosthuyse (1993) suggested a link between mango skin colour after cold storage, and the amount of N applied by the grower. It appeared that fruit from orchards with a low N-status de-greened completely while those from moderate or high N orchards either failed to de-green or did not de-green appreciably. This study further examines fruit colour of export samples and the relationship to orchard N-status.

MATERIALS AND METHODS

Fruit arriving on the markets was regularly sampled by South African industry representatives. Photographs of some 900 cartons of mango fruit taken on removal from cold storage, and after 4 days at ambient room temperatures, were analyzed to assess background skin colour. This is not the red blush colour which is usually dependent on the degree of sunlight received, but rather the green or yellow background skin colour. Average fruit colour in each carton was rated on a scale of 0 to 3 (Table 1). Other factors such as disease or physiological disorders were ignored.

Within each cultivar samples were grouped according to grower. An aggregate colour rating expressed as a percentage was used to rate growers. An attempt was then made to link these ratings against what may best be described as the orchard N-status.

Each grower involved was questioned in an attempt to determine his orchard N-status, specifically during the fruit development stage. Leaf analysis the previous November was the most useful parameter, but in its absence additional factors

such as the amount, timing and type of N applications, tree age and size, soil type, and irrigation type and use were considered. N-status was then classified as low, moderate, or high. This classification was at best a rough assessment, especially if leaf analysis was not available. Growers were also asked for their opinions as to the reasons behind adequate or inadequate de-greening.

RESULTS

The relevant information could not be obtained from all growers, either through lack of response, inadequate grower information, or because some export agents understandably chose to keep certain grower codes confidential.

Cultivar differences

The most prominent result from the skin colour classification was the cultivar difference (Table 2). The feedback from Europe was that skin colour was predominantly a problem in Sensation and Kent. While the average rating of Sensation was acceptable, it was the cultivar with the greatest variation. Heidi and Isis colouration was excellent with Tommy Atkins and Haden being good. Kent and Keitt colour was very poor.

The second striking point about the results was that the skin colour of fruit produced by each grower was fairly uniform. Certain growers consistently produced yellow fruit, others green fruit, and a third group had fruit between the two extremes. This occurred across cultivars in that growers with well coloured fruit in one cultivar tended to have the same result with the others.

Sensation

Sensation was the cultivar with the biggest differences, and the greatest number of cartons and growers from which to work. It therefore provided the most interesting results. Table 3 shows a list of growers, classified according to mango skin colour of the export samples, and the orchard N-status. As can be seen there is a good relationship between colour rating and the N situation. Generally where the N levels were low, colour was good. Colour rating, on average, deteriorated with increasing N-status.

Other cultivars

A similar trend was noted for Kent, Keitt, and Tommy Atkins. There was insufficient data on the other cultivars to make any assessments.

General observations

Those growers with a low N-status and generally yellow fruit were quick to cite N as playing a pivotal role in this regard. Some also noted the importance of selective picking, especially in Sensation. Most of the remaining growers, whose fruit was intermediate to very green, were unsure as to reasons for inadequate de-greening. Also interesting to note was that growers with high or moderate N-status were following industry recommendations, while those with low N-status were deliberately avoiding standard N recommendations.

Several growers noted that under the same fertilization regimes, trees on sandy or lighter soils tended to produce well coloured yellow fruit compared to those of the same cultivar grown on heavier clay soils.

Green fruit seemed more prevalent where organic fertilizers, particularly untreated manure, were used to extend high N levels right through the fruit development stage.

Table 1 *Mango background skin colour ratings used to rate export sample cartons.*

Rating	Description
0	Dark green fruit with no yellow colouring. Blush shows up as purple rather than red. Unacceptable fruit
1	Light green, with some yellow. Marginal to unacceptable fruit colouration
2	Mostly yellow, some green. Acceptable fruit
3	Yellow fruit, no green. Very good quality

Table 2 *Mango skin colour ratings (the average, expressed as a percentage) of export samples from the 1992/93 and 1993/94 seasons.*

Cultivar	Number of samples	Colour rating (%)
Heidi	7	100.0
Isis	16	91.7
Haden	7	71.4
Tommy Atkins	171	70.4
Irwin	10	63.3
Sensation	295	60.1
Zill	91	53.1
Keitt	119	40.1
Kent	163	29.9

Table 3 *Sensation mango skin colour ratings (the average, expressed as a percentage) of 14 growers and an assessment of their orchard N-status during the fruit development stage.*

Grower	Colour rating (%)	Number of samples	N-status assessment
A	95.2	7	low
B	83.3	6	low
C	77.8	3	low
D	76.2	12	moderate
E	69.5	12	high
F	66.7	5	moderate
G	66.7	3	moderate
H	64.3	28	moderate
I	63.3	20	low
J	53.3	5	moderate
K	50.0	4	moderate
L	46.0	12	moderate
M	33.3	5	high
N	23.8	7	high

DISCUSSION AND CONCLUSIONS

It appears from this survey that there was a strong link between tree N levels and ability of the mango fruit to de-green. Leaf norms have traditionally been calculated according to yield per tree. Quality and fruit colour, particularly after early picking and extended cold storage, have not previously been objectives of leaf norm establishment. N is known as a manipulative nutrient. Reducing leaf N levels may well im-

prove fruit quality and colour but according to Smith (1994) this could have serious yield implications. However, yield in kg per tree is different from profit per ha. Price per kg is affected by fruit size which, in Sensation, tends to improve with reduced N levels (Smith, 1994). Further, a higher price can be obtained for better fruit colour, and in future it may be impossible to sell green fruit on the European markets. These norms are established over several years on trees which receive different N applications. Higher N applications over some years should result in increased tree size and thus in increased cumulative yields per tree. Today however, under current high density plantings it is yield or income per ha, and not per tree that is important. Also, these norms have often been established on N regimes which included year round split applications. There is now a general trend to avoid or reduce applications during the fruit growth period. While leaf norms should represent an absolute tree response, they are based on annual sampling. Changes during the remainder of the year may also be a function of soil and climatic conditions. Leaf norms based on single site experiments may therefore be impaired. This means that leaf norms for November sampling need re-assessment.

It is recommended that growers carefully consider their N regimes. It is impossible to make any determinations without regular annual leaf analysis. These should be taken in November, and together with that season's crop load, fruit quality assessment and details on previous N applications, used to calculate N requirements. In general, applications should be kept low, with a desirable N leaf level probably around 1.2%. All, or nearly all of the N should be as post-harvest applications, split if necessary. This should be followed by good irrigation. Care should be taken with organic fertilizers. Untreated manure with uncontrolled C:N ratios should be avoided. Commercial organic formulations where the C:N ratio is such that N release would not be extended through to the fruit growing period should be acceptable.

Growers must understand that a reduction in N levels poses a risk of yield loss. The damage to, and loss of European market share by the continued provision of green fruit, often with a high incidence of N-related physiological disorders is however, a much more serious problem.

Future Research

In order to confirm the above findings and to establish new leaf norms for the export industry a different approach is necessary. The use of laborious field trials testing a limited number of nutrients within a limited range on a limited cultivar number is tedious, and takes several years to yield useful results. An alternative approach is elucidated by Leece (1968) in which fruit tree leaf analysis interpretation is based on surveys, where the ranges in nutrient concentration in high production orchards are determined. Kenworthy (1961) showed that in the absence of detailed field or pot experiments, tentative leaf standards for fruit trees with stable coefficients of variation can be determined using this technique. These standards normally hold good in subsequent years in the location in which they were developed, and are also valid in other regions and countries (Leece, Cradock and Carter, 1971). Menzel, Carseldine, Haydon and Simpson (1992) cited this approach and used it very successfully in litchi. Based on a combination of survey and existing standards, new leaf nutrient norms can then be proposed.

The expansion of this approach to include a range of trees, not just high producing ones is necessary in mango. There is a need to determine the effect of N levels on yield as well as quality and colour. Growers need to know how far they can reduce N levels to effect good de-greening without seriously compromising yield.

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