Chapter 5

DISCUSSION

5.1. Contributions of staking, plant spacing and potassium to the yield and the yield components

Plant spacing had significant effects on the marketable yield, the number of fruits per plant, the average fruit weight and the yield per plant. Plant spacing also interacted with staking to affect marketable yield, and with K fertilizer to affect the number of fruits. This discussion will focus on the interaction effects of the factors.

In terms of yield, the highest marketable yield, 64.94 t/ha, was obtained in 45 cm plant spacing with staking treatment; and the lowest one, 45.62 t/ha occurred in 15 cm plant spacing with nonstaking treatment. When nonstaking cultivation is practiced, plant spacing of at least 30 cm should be recommended due to higher marketable yield than the closer spacing. Plant spacing of 45 cm did not give significantly higher yield than at 30 cm (Table 4). These results do not agree with other experiments (Rumpel and Babik, 1989; Taha, 1984; Candilo, et al., 1985; and Pimpini and Gianguinto, 1990), which all reported to have higher yields in the higher plant density, or closer plant spacing. This might be because the variety used in this experiment, VF 134-1-2, was a semideterminate growing type. In general,

this type of variety can branch extensively and set more and bigger fruits in the wider plant spacing.

Regarding the number of fruits, Table 6 indicates that within the same level of K fertilizer, as the plant spacing increased, the number of fruits increased significantly. Comparing the K effect in the same plant spacing level, the number of fruits did not change uniformly. However, it is clear that K fertilizer had a more beneficial effect on the 45 cm plant spacing treatments than it did on the 30 and 15 cm spacings. At wider plant spacing, plants can set and produce large number of fruits if potassium is enough. If potassium is inadequate, plants can set, but cannot produce a large number of fruits (Gould, 1974). When plants cannot get enough potassium, the foliage is often sacrificed, thus leaving the fruit exposed to the hot sun. The fruit then is scalded or sunburned as it ripens and may spoil before it is ready to pick.

The wider plant spacing also produced a greater average fruit weight and a higher yield per plant than the closer one did. Similar findings were reported by Rumpe and Babik (1989); and Pimpini and Gianguinto (1990).

The fact that staking with banking, or staking alone increased the yield of tomato was reported by AVRDC (1985) and Horvatich (1985). However, both staking and K fertilizer did not have significant individual effect on the marketable

yield as well as the total yield and yield components in this study. The interaction effect on the yield between staking and plant spacing suggests that staking had a more favorable effect in the closer plant spacing, i.e. 15 cm, than that in the wider plant spacing of 30 and 45 cm. Table 4 shows that staking had a significantly higher marketable yield at 15 cm plant spacing, but not at 30 and 45 cm spacing. This agrees with the hypothesis of the study. In the dense population or close plant spacing treatments, staking could hold the plant above the ground and create good ventilation. Consequently, plants performed better with greater reception of sunlight, more efficient CO_2 uptake and reduced infection by diseases under the better "microenvironment". In the wider plant spacing, the effects of staking become less. Staking could reduce the unmarketable yield by preventing the fruits from touching the ground and reducing the incidence of disease.

The effect of potassium on the tomato yield was not as pronounced as that of nitrogen (Trudel and Ozbun, 1970). In this study, K did not show any striking effects on the yield and the yield components. The interaction effect on the number of fruits per plant between plant spacing and K fertilizer was discussed above. On the basis of plant leaf analysis, K uptake by the plants in all K fertilizer treatments (Table 14) were much higher than the severe

deficiency level of 2% K and they were around the critical level of 4% for the fruit yield (Sobulo, Fayemi and Agboola, 1975). The yields of all K treatments in this experiment were relative high for VF 134-1-2 variety in the tropics. Therefore, the yield and the yield components did not respond to the K fertilizer applications. High K content in the soil after harvesting of tomato in the K(0) treatment is unexpected. Despite the low K in the experimental plots (Table 1) just after harvesting rice, K level in soil will increase gradually because of decomposition of the rice roots and the rice straws in the fields, and from the manure applied before transplanting of tomatoes to provide favorable root environments for tomato seedlings.

5.2. Processing quality

Total solids and soluble solids were not affected by staking, plant spacing and potassium individually. But interaction effect on total solids and soluble solids among the staking, plant spacing and potassium were found. Tomato fruit solid is influenced by both environmental factors, e.g. light intensity, photoperiod, weather conditions, and genetic factors (Tigchelaak, 1970). There has been no evidence that shows the effects of staking and plant spacing on the fruit solids of tomatoes. However, tomato fruits from the plants well supplied with K were generally higher in total solids, soluble solids, mainly sugar and acids

(Uexkull, 1978). In this experiment, K did not affect the total solids and soluble solids significantly. But it had interaction effects on total solids and soluble solids with staking and plant spacing, respectively. The K uptakes by plants in all K fertilizer treatments (Table 14) were not high enough for the requirement of tomato compared with the recommended level of 6% in the plant (Gallargher, 1972). Uexkull (1978) mentioned that the effect of K on quality went far beyond the level needed for higher yield. In many cases highest yields were obtained at 150 - 300 kg K_2O/ha, but highest quality was obtained at 600 - 800 kg K_2O/ha. According to the soil analysis, K residuals in the soil were significantly different between the K treatments. K residuals of K (200) and K(300) were markedly higher than that of K(0) and K(100) treatments. This evidence indicates that even if there exists plenty of available K in the soil, plants could not efficiently take it up. This deserves further study for the causes and mechanism of low K uptake.

Total acidity, primarily citric acid and malic acid contributes to the tartness or sour flavor. Different effects of K fertilizer on total acidity were found in this experiment (Table 9). An increase in total acidity was associated with the increment of K level. A similar result was reported by Winsor (1963). This result is also consistent with the statement explained by Uexkull (1978).

5.3. Economic consideration

Economic analysis was conducted based on the increased cost of production and return on different spacing, staking and fertilizer treatments. In this experiment, staking and plant spacing had interaction effects on the marketable yield. Detailed budget analysis on staking for different spacings as shown in Table 16, shows that staking in all spacing treatments had negative gain, even though staking resulted in a significantly higher marketable yield at 15 cm plant spacing. This is due to the high wage rate for labor at the experimental station. The total cost for labor used in staking was 16,640 baht/ha, accounting for 81.2% of the total cost 20,500 baht/ha in staking (Tablb 17). If the labor cost for staking was extracted from the incremental costs, the net gain of 15 cm plant spacing would be 16.628 baht/ha. Under the farmers' circumstance, farmers can gain benefits from staking if they use 15 cm spacing and their family labors.

The effects of staking on yield are greatly dependent on the variety used, the style of staking and the growing seasons. In general, greater effects take place on the indeterminate type than on the determinate one. The stronger staking should provide better results. Furthermore, staking used in the wet seasons should raise the proportion of marketable yield. This study was conducted in the dry

season, the variety used was determinate type, and the staking was made rather late due to labor shortage. According to the field observation, the staking was not strong enough to support the plant and the fruits, thus many fruits were still on the ground.

Table 16. Budget analysis on staking for different spacings averaged over K treatment

Plant spacing	Increments		Incremental cost		Net gain
	Yield[a]	Return[b]	Staking[c]	Harvesting[d]	
(cm)	(t/ha)	(Baht/ha)			
15	12.80	23,048	20,500	2,560	-12
30	3.73	6,714	20,500	746	-14,532
45	2.06	3,708	20,500	412	-17,204

[a]Yield increased by staking for particular plant spacing (Table 4).

[b]The average price of tomato paid by the processing factory is 1,800 baht/t.

[c]Including the cost of the labor, bamboo sticks and binding materials.

[d]The cost for harvesting is 200 baht/t.

Providing potential improvements in yields, staking can become profitable particularly when family labors are used. The calculation above was based on the price paid by the processing factory which is considerably low. The break-even price, however, calculated for the marketable yield is 3,500 baht/ton.

Table 17. Detailed budget for staking treatment averaged over the plant spacing and K fertilizer treatments

Item	Baht/ha
Increased return from staking	11,160[a]
Increased Cost:	
Labor cost for staking	16,640[b]
Staking materials	3,360[c]
Plastic bands	500
Total incremental cost	20,500

[a]Equals to 6.20 x 1,800 (6.20 is the yield increased in t/ha, derived from Table 4; and 1,800 is the price of tomato in baht/t).

[b]Equals to 208 mandays x 80 baht/day (208 is the mandays of labor used 80 is the wage rate, baht/day).

[c]Equals to the total cost for bamboo sticks divided by 3, because the bamboo sticks can be used for 3 years.

Because of insignificant differences in marketable yield of tomato, there was no economic advantage of applying K fertilizer in this study. The extra costs of K fertilizer were 1,760, 3,520, 5,280 baht/ha for 100, 200 and 300 kg K_2O/ha respectively.

Even if K can improve tomato color, the processing plants do not grade the tomato fruits when they produce tomato paste. Therefore, the farmers were not paid for the improved color fruits.

It seems that possibility for the application of staking in farmers' fields is less likely since yield obtained by the farmers in San Sai was only 33 t/ha, and the effect of staking on marketable yield at 30 and 45 cm plant spacings (farmers' spacing range) was not profitable. Staking is economically feasible only at a high price to compensate for the cost of staking.