CHAPTER 5

Discussion

5.1 Experiment 1: Effect of stake soaking on various cassava varieties

Stake priming was an effective method to improve nutrient status in cassava production when nutrient deficiency was the limiting factor. Experiment 1 focused on stake priming with a complete nutrient solution on five cassava varieties. The complete nutrient solution is a way to improve cassava yield for many locations when it is not known exactly which nutrient is limiting. The result showed that stake priming with complete nutrient solution increased root yield. It indicated that stake priming with a single nutrient such as Zn had a positive response (Watanaonta et al. 2004; Wargiono and Ispandi 2007; Paisancharoen et al. 2010). However, four out of five varieties; Rayong 5, Rayong 7, Rayong 9 and Rayong 72 responded positively to stake soaking while KU 50 showed no response. Watananonta et al. (2004) in Huay Bong, Thailand found that in KU 50 priming had no effect on root yield while yield of Rayong 72 was increased by stake priming. Thus the priming effect depends on cassava varieties. Increase of yield by priming relates to increasing whole plant N, P and K, indicating that priming enhances plants nutrient uptake.

The starch contents of all varieties in this experiment were lower than other studies (average 25% by Prammanee et al. 2010 and average 24% by Watananonta et al. 2004) because of very high root water content as the crop was harvested in the middle of the rainy season. Nevertheless, stake priming promoted starch content.

5.2 Experiment 2: The responses to stake priming in KU 50 from different sources in Lao PDR on growth and yield

Previous studies have shown stake quality can be the primary factor that limits cassava yield (Molina and El-Sharkawy 1995; Eke-Okoro et al. 2001; Eze and Ugwuoke 2010); this study has shown how cassava root and starch yield can be significantly influenced by stakes. Furthermore, the cases of KU 50 from four sources illustrated how the root and starch yield of cassava can be much enhanced by stake priming with nutrient solution although the soil property of the site was low in pH, organic matter, K and Zn as well, compared to published information on nutritional requirements of cassava in soil (Howeler 1996). These results are similar to the recommendation of Howeler (1981, 2002) that Fe or Zn deficiency can be overcome by pre-planting the stake treatment with a solution of Fe_2SO_4 or $ZnSO_4$, respectively. A positive response to stake priming with Zn in cassava root yield was reported from Colombia (CIAT 1985), Thailand (Watanaonta et al. 2004) and Indonesia (Wargiono and Ispandi 2007). Priming stake of cassava before planting could be a method to overcome nutrient deficiency to improve cassava production.

5.3 Experiment 3: Response to stake priming in cassava varieties from different sources in Thailand on growth, yield and nutrient accumulation

Rayong 72 and KU 50 grown from stakes from Mahasarakham (at final harvesting) illustrated how root and starch yield and accumulation of nutrients of the cassava can be much enhanced by stake priming with a nutrient solution. Which of the 15 elements in the nutrient solution are the limiting factors? Did priming help to overcome trace or major element deficiency in the stake or in the soil or both? These questions still need to be clarified.

A key role played by stake K in the present study was suggested by the evidence of stake nutrient concentration and fertility characteristics of the soil on which the experiment was conducted. At 0.13 meq 100 g^{-1} the experimental soil was low in K according to the standard fertility for cassava (Howeler 2001). Potassium concentration of stakes from Mahasarakham was also lower than that from the other two sources and in the same range that reportedly depressed stake growth and root yield (Molina and El-Sharkawy 1995). However, there was a lack of response to priming in Rayong 72 at final harvesting although the K concentration of its stakes from Mahasarakham was even lower than that in KU 50 from the same source that responded positively to priming. The effect of K fertilizer on increasing cassava root yield is associated with its effect on increasing root number (Suyamto 1998). Similarly, priming which increased root and starch yield of KU 50 grown with stakes from Mahasarakham also increased its root number.

However, priming had no effect on root yield of KU 50 grown from stakes from Mahasarakham at first harvest. A period of 120–150 days after planting, maximum canopy and dry matter partition of leaves and stems occurred in this period, and a high amount of carbohydrates was translocated to roots during 180−300 days after planting (Howeler and Cadavid 1983; Pellet and El-Sharkawy 1997; Alves 2002). In such conditions, the effect of priming on root and starch yield in Rayong 72 grown from stakes from Mahasarakham and KU 50 grown from stakes from Chiang Mai was not clear at first harvest (at four months after planting). Similarly cassava varietal response to fertilization had no effect on storage roots at two and four months after planting, but the effect of fertilization on storage roots was clear at six months after planting (Pellet and El-Sharkawy 1997).

Significant interaction between the effect of stake source and variety on whole plant N, P and K found in this study suggested how root function and nutrient uptake of cassava may vary with the quality of the stake. Stake quality in cassava, which might be defined as the capacity for regeneration when planted, is influenced by the condition under which the mother plant is grown and is governed by reserves of organic compounds and mineral nutrients that can be mobilized for growth of the first roots and leaves. However, the significant interaction between the effects of stake source and stake priming with mineral nutrients found in this study, along with reports of response to priming with single nutrients such as Zn reported by others (e.g. Watananonta et al. 2004; Wargiono and Ispandi 2007) or together point to (a) the key role of mineral nutrients as a determinant of stake quality, and (b) the practical implication that nutrient priming may help to overcome any shortfall in stake quality.

5.4 Experiment 4: Response to stake priming with nutrient solution on germination and early growth

First sprouting on the bud of the stake begins five to eight days after planting then flowering of small leaves occurs (El-Sharkawy 2003). Similarly in this study sprouting of all treatment stakes occurred at five and ended at nine days after planting.

Shoot and root growth are influenced by food and nutrient reserves of stakes. In the case of stake priming wherever a complete, Ca, B or Zn nutrient solution plays role important of higher plants germinated. Sprouting of stakes has been reported to correlate with their starch content (CIAT 1988). Moreover, the sprouting and root formation of stakes was strongly influenced by N, P and K reserves in stakes; low sprouting and small rootlets was occurred in stakes from mother plants with no K application indicating that stake sprouting and subsequent growth and yield were much more closely associated with K content than its carbohydrate or sugar content (Molina and El-Sharkawy 1995). Faster plant germination obtained via stake priming was found in this study. Moreover, more root number and root dry weight were influenced by wherever stake priming was conducted with complete or single nutrient solutions. This indicates that not only complete nutrient reserves in stakes play an important role on germination and early growth but single nutrients such as Ca, Zn and B or other single elements also effect germination and early growth. Specific nutrients that benefit cassava production need to be investigated. The suggestion by Lebot (2009) that cassava germination and growth are influenced by stake planting position with no consideration of nutrient reserves in stakes should be re-examined to include nutrient reserves of stakes.

5.5 General discussion

Priming stakes in nutrient solution before planting has been suggested as a means to improve performance of cassava in soils where availability of some nutrients may be limited. Thus it is recommended for cassava-growing areas on calcareous soils in Central America to Southeast Asia that the problem of Fe or Zn deficiency can be overcome by pre-planting the stake treatment with a solution of $FeSO_4$ or $ZnSO_4$, respectively (Howeler 2002). Positive responses to stake priming with Zn in cassava root yield have been reported from Colombia (CIAT 1985), Thailand (Wattananonta et al. 2004) and Indonesia (Wargiono and Ispandi 2007). Their findings are similar to the result in experiment 1 that priming can overcome nutrient deficiency of stakes. But the effect of priming depends on cassava varieties. However, cassava yield varies greatly depending on pests, diseases and nutritional status of the mother plant where the stakes were taken (Clock 1985); this means stake quality was determined by nutrient content in stakes or where the mother plants were grown (Molina and El-Sharkawy 1995). To confirm the above findings, experiment 2 was conducted by testing KU 50 from different sources. The result shows that the effect of stake priming on cassava root and starch yield not only depends on cassava varieties (experiment 1) but it also depends on stake sources. These findings indicate that enhanced nutrient status due to priming is the way to overcome the problem of nutrient deficiency. In experiment 3, two cassava varieties grown from stakes from various sources showed different responses to stake priming; previous suggestions (CIAT 1985; Howeler 2002; Wathananonta et al. 2004; Wargiono and Ispandi 2007) indicated that priming stake with a single nutrient can enhance growth and yield in cassava when nutrient deficiency is the limiting factor; ignoring the stake sources of various varieties should be re-examined in order to include various varieties from different sources for improving growth and yield in cassava production.

The importance of nutrient content of propagules on their ability to regenerate is well documented for many nutrients in a whole range of crops grown from seed, e.g. from seed B in black gram and green gram (Rerkasem et al. 1990) and soybean (Rerkasem et al. 1997); seed manganese (Mn) in lupin (Longnecker et al. 1991) and barley (Crosbie et al. 1994); seed molybdenum (Mo) in soybean (Gurley 1969); seed

P in lupin (Thomson et al. 1992) and subterranean clover (Thomson and Bolger 1993); to seed Zn in barley (Genc et al. 2002) and wheat (Yilmaz et al. 1998). The result in experiment 4 showed that priming with Ca, B and Zn enhanced faster plant germination and higher root, shoot and total plant dry matter. Higher establishment in the vegetative growth stage of cassava affects the final yield. It was confirmed in experiments 1, 2 and 3 that priming of cassava stakes enhances better germination and establishment affecting final root and starch yield.