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IMPROVING OF MAIZE YIELD AND PROFITABILITY THROUGH SITE-SPECIFIC NUTRIENT MANAGEMENT (SSNM) AND PLANTING DENSITY

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ABSTRACT

Maize is the second most important cereal crop after rice in Southeast Asian countries. Currently recorded average maize yields compared with the yield potential for a given variety and climate indicate significant opportunities to further increase maize productivity through site-specific, integrated nutrient and crop management. The on-farm experiments were conducted at Tanchau district, Angiang Province, Vietnam in 2008 wet season and 2009 dry season on maize-maize-rice cropping system. The 7 treatments with 10 on-farms were combined with the planting densities and spacing: regular density 67,000 plants ha^{-1} (75x20 cm), and improved spacing, planting density (iPD) (40+80) x 22 cm; 60x22 cm with high plant density 76,000 plants at fertilizer application methods: FFP (fertilizer farmer practices), ICM with higher NPK rate and the omission plots of N, P and K in a randomized completed block design. The results revealed that maize yields of 8-9 t ha^{-1} can be achieved in Tanchau, Angiang (2008-2009). The highest grain yield was recorded at 8.92 t ha^{-1} on alluvium soil in dry season and 7.93 t ha^{-1} in wet season. Yields increased of about 0.3-0.6 t ha^{-1} by increasing plant density and spacing. Improved planting density 60 x 22 cm (76,000 plants) with higher NPK rate of ICM got higher grain yield from 0.77- 1.27 t ha^{-1} compared with FFP and 75x20 cm (67,000 plants). The higher net benefit got 1.3-1.4 million VND ha^{-1} and 1.2-1.7 million VND ha^{-1} in 2008 WS and 2009 DS compared with FFP and low plant density, respectively.

Keywords: fertilizer farmer practices (FFP), grain yield (GY), improved planting density (IPD), Integrated Crop Management (ICM), Regular density (RD), Site-Specific Nutrient Management (SSNM)

INTRODUCTION

In Vietnam as well as in many Southeast Asia countries, maize is the second most important cereal crop after rice. Although the maize area and yield continuously increased in recent years, but it get lower grain yield than the other countries. Otherwise, the maize productivity of Vietnam as well as the Mekong Delta is very large, in which Angiang is the one of provinces that was fairly high yield with 8,900 ha in 2004 and the average maize yield with 7.4 t/ha and the productivity of 77,000 tons. For getting the best goal, the approaches are quickly expansion of growing areas with good maize varieties and combined with intensive crop managements. Moreover, currently recorded average maize yields compared with the yield potential for a given variety and climate condition indicate that significant opportunities to further increase maize productivity through site-specific, integrated nutrient and crop management (Dobermann et al. 2003; Witt et al. 2004; Khuong et al. 2008). So, the objectives of this research are to determine the effect of Site-Specific Nutrient Management (SSNM), and to improve planting density, spacing on grain yield and economic efficiency.

MATERIALS AND METHODS

The experiments were conducted on ten farmer fields at Tanchau, Angiang in 2008 wet season and 2009 dry season on the Maize-Maize-Rice

cropping system. The experiment was comprised of 7 treatments which were the combination of planting densities and fertilizer application methods. The planting densities were regular density (67,000 plants/ha) with spacing of 75x20 cm, improved planting density; change spacing (iPD) (40+80)x22 cm; 60x22 cm (76,000 plants) and high fertilizer of ICM with use LCC. The fertilizer application methods included of fertilizer farmer practice (FFP) and Site-Specific Nutrient Management (SSNM) (Table 1). The omission fertilizer plots were +PK, +NK and +NP.

The experimental soil was a loamy alluvium with the contents of 40% sand, 51% silt and 9% clay at 0-20 cm layer and 40% sand, 49% silt and 11% clay at 20-40 cm layer. The chemical soil properties were low in organic C and total N, medium-high in P, low-medium in K, low in Ca and Mg, no micro-nutrients deficiency and no soil toxicity.

The maize variety of G49 with 90-95 days growth duration was used in both seasons. Data of yield components and grain yield were collected and calculated the economic efficiency of improvement of planting density and fertilizer application method followed by the procedure of IRRI (Fairhurst et al. 2005) and IPNI.

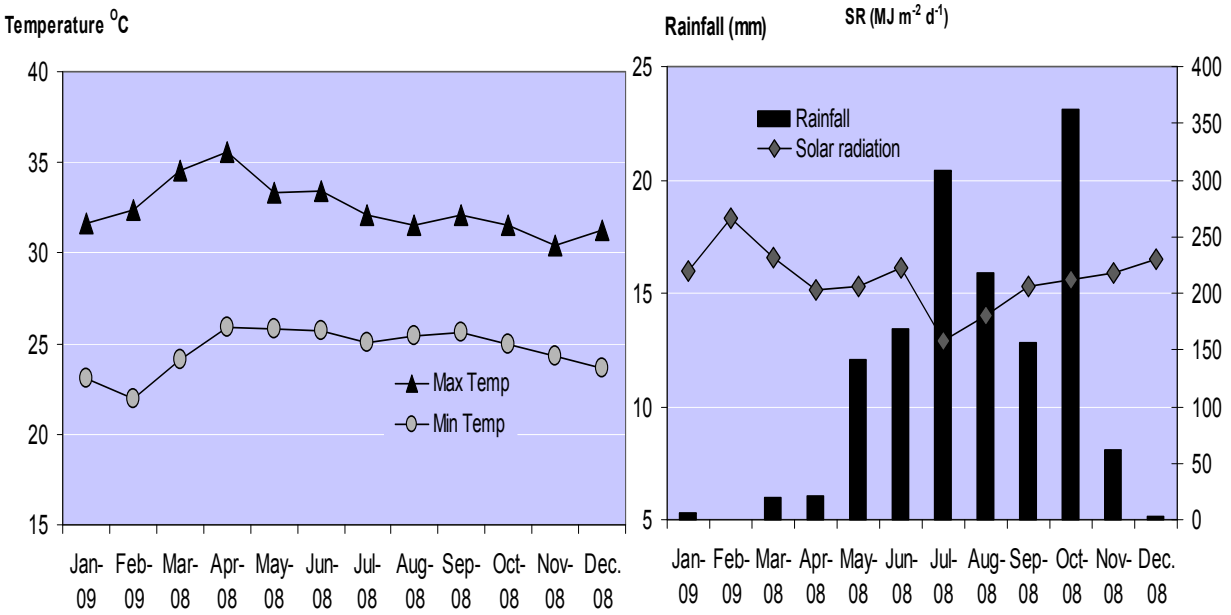

Fig. 1: Temperature, Rainfall and Solar Radiation in 2008-09, An Giang province

In 2008 WS, maize was grown from March 20-24th; harvest on June 25-29th, and in 2009 DS, it was grown from November 3-20th; harvest on February 8-25th. Rainfall was highest on July, October and lowest or no rain on December, January and February. Air temperature was highest on April and lowest on January and February. Solar radiation was highest on February and lowest on July.

Table 1: Fertilizer rate in FFP and SSNM treatments for Maize G49 at Tanchau, Angiang.

Year	FFP (kg/ha)			ICM (kg/ha)		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
2008 WS	184	86	63	200	90	60
2009 DS	182	75	73	197	100	90

RESULTS AND DISCUSSIONS

Effect of planting density and fertilizer application methods on yield components and grain yield

In 2008 WS and 2009 DS, the ear number/ha among fertilizer treatments and planting densities, spacing varied from 67,000-79,000 ears/ha at iPD-(40+80)x22 cm; 60x22 cm and ICM. The kernel No/ear got highest value at the SSNM and plant density 75x20 cm treatment (411 kernels/ear in 2008 WS and 429 kernels/ear in 2009 DS). The difference on the kernel No/ear was clearly varied between the omission plots of PK, NK and NP. The SSNM treatment got the higher ear No/ha than that of FFP treatment. The treatments of IPD-(40+80)x22 cm; 60x22 cm got the higher ear No/ha than those of regular plant density 75x20 cm. The averaged weight of 100 grains of G49 varied from 26.9 to 27.3 g at the SSNM and FFP treatments, but it only got from 21.5-26.9 g in the omission fertilizer treatments. Spacing change with the same plant density did not significantly differ on the kernel No/ear and weight of 100 grains (Fig. 2 and 3)

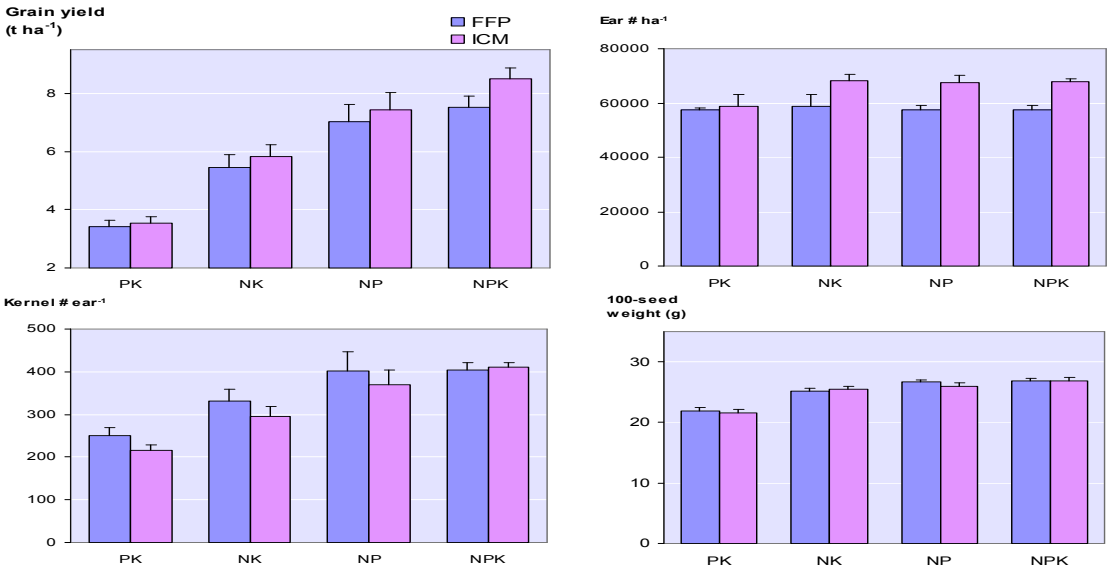

Fig. 2: Grain yield and yield components of Maize G49 at Tanchau, Angiang in 2008 WS

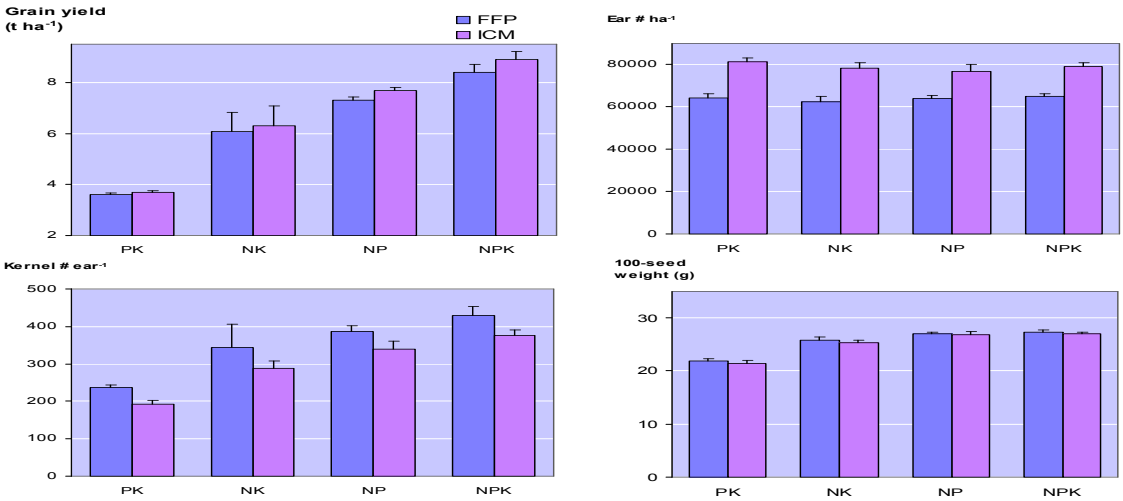

Fig. 3: Grain yield and yield components of Maize G49 at Tanchau, Angiang in 2009 DS

The grain yield of G49 got the highest value at SSNM and improved planting density, spacing (IPD-(40+80)x22 cm; 60x22 cm). It got 7.73-7.93 t/ha in 2008 WS and 8.32-8.92 t/ha in 2009 DS. The combined treatment of NPK and ICM plant density, spacing-((40+80)x22 cm; 60x22 cm) obtained higher grain yield than that of the FFP and regular planting density (75x20 cm) treatment. No nitrogen fertilizer application, the grain yield was very low. It got only 3.41-3.53 t/ha in 2008 WS and 3.59-3.68 t/ha in 2009 DS. Without phosphorus, the grain yield of WS was lower than that of DS. It got 5.46-5.83 t/ha in 2008 WS compared to 6.07-6.31 t/ha in 2009 DS. No potassium fertilizer application, the grain yield was got higher than without phosphorus (Fig. 2 and 3). These data affirmed that hybrid maize need high dose of nitrogen, phosphorus nutrient. The SSNM method with higher applied-nutrients, especially nitrogen, adequately responded the plant need that led to getting higher grain yield than FFP treatment (Table 1).

Effect of planting density and fertilizer application methods on profitability of maize

Compared to FFP, SSNM method combined with improved planting density and spacing-(iPD) gave the highest profit for both seasons (Table 2 and 3). The increased profit of SSNM-iPD treatments were 1.3-1.4 million VND/ha in 2008 WS and 1.2-1.7 million VND/ha in 2009 DS.

Table 2: Economic analysis of planting densities and fertilizer application methods on maize G49 at Tanchau, Angiang in 2008 WS.

Parameters	Treatments			
	FFP (75x20)	FFP (40+80)x22	ICM (40+80)x22	ICM (60x22)
Yield (t/ha)	7.16	7.42	7.73	7.93
Price of corn (VND/kg)	3,200	3,200	3,200	3,200
Gross benefit (VND 1000 /ha)	22,912	23,744	24,736	25.376
Total fertilizer cost (VND 1000 /ha)	7,060	7,032	7,443	7,258
Total seed cost (VND 1000 /ha)	738	839	839	839
Net benefit (VND 1000 /ha)	15,114	15,874	16,454	17,280
Profit (ICM) (VND 1000 /ha)	-	-	1,341	1,406

Table 3: Economic analysis of planting densities and fertilizer application methods on maize G49 at Tanchau, Angiang in 2009 DS.

Parameters	Treatments			
	NPK (75x20)	FFP (75x20)	NPK (60x22)	ICM (60x22)
Yield (t/ha)	8.41	7.65	8.92	8.32
Price of corn (VND/kg)	3,800	3,800	3,800	3,800
Gross benefit (VND 1,000 /ha)	31,938	29,054	33,876	3,160
Total fertilizer cost (VND 1000 /ha)	7,526	5,687	7,526	6,805
Total seed cost (VND 1000 /ha)	954	954	1,188	1,188
Net benefit (VND 1000 /ha)	23,489	22,241	25,163	23,610
Profit (ICM) (VND 1000 /ha)	-	-	1,673	1,196

CONCLUSSION

Maize yield of 8-9 t ha^{-1} can be achieved in Tanchau district belong Angiang province. The highest yield was recorded at 7.93 t ha^{-1} on alluvium soil in wet season and 8.92 t ha^{-1} in dry season. Yield increased of about 0.3-0.6 t ha^{-1} by increasing plant density. Grain yield increased 0.5-0.7 ha^{-1} by SSNM method. At planting density of 67,000 plants ha^{-1}, improved plant spacing (60x22 cm) gave a better grain yield as compared to farmer's plant spacing (75x20 cm). Improved planting density with higher NPK rate of SSNM

(use LCC), the GY was recorded higher by 0.77-1.27 t ha^{-1} and the profit of maize production was increased by VND 1.4 million and VND 1.7 million in 2008 WS and 2009 DS, respectively. Yield increased of about 0.26 t ha^{-1} by improved plant density FFP ((40+80)x22 cm) compared to FFP (75x20 cm) in 2008 WS.

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Cải thiện năng suất và lợi nhuận bắp lai bằng biện pháp bón phân theo địa điểm chuyên biệt và cải tiến mật độ cây, khoảng cách cây

Ở các nước Đông Nam Á, bắp là cây lương thực quan trọng đứng thứ hai sau lúa. Các ghi nhận gần đây cho thấy năng suất bắp trung bình so với tiềm năng suất của một giống trong điều kiện khí hậu nhất định có cơ hội gia tăng hơn nữa bằng biện pháp quản lý cây trồng và dinh dưỡng tổng hợp. Các thí nghiệm đồng ruộng được thực hiện trên 10 ruộng nông dân ở Tân Châu, An Giang trong hai vụ HT2008 và ĐX2008-09 trên cơ cấu 3 vụ bắp-bắp-lúa/năm. Thí nghiệm được bố trí theo khối hoàn toàn ngẫu nhiên với 7 nghiệm thức là sự kết hợp giữa 2 mật độ cây (75x20 cm và 60x22 cm) trong vụ ĐX, 2 mật độ cây và 3 khoảng cách (70x20 cm; (40+80)x22 và 60x22 cm) trong vụ HT và các phương pháp bón phân (bón phân theo nông dân-FFP; bón phân theo địa điểm chuyên biệt-SSNM kết hợp với sử dụng bảng so màu lá (ICM) và các lô khuyết không bón phân N, P và K).

Năng suất bắp ở Tân Châu, An Giang có thể đạt được từ 8-9 t/ha. Năng suất bắp cao nhất trên đất phù sa trong vụ HT2008 là 7,93 t/ha và 8,92 t/ha trong vụ ĐX2008-09. Năng suất gia tăng do cải thiện mật độ cây là từ 0,5-0,7 t/ha. Ở mật độ 76.000 cây/ha, khoảng cách cải tiến iPD (60x22 cm) đạt năng suất cao hơn so với mật độ trồng của nông dân (75x20 cm) là 0,3-0,6 t/ha. Mật độ cây cải tiến kết hợp với mức phân bón cao hơn của SSNM gia tăng được 0,77-1,27 t/ha trong cả 2 vụ. Lợi nhuận gia tăng được 1,4 triệu đồng/ha trong vụ HT2008 và 1,7 triệu đồng/ha trong vụ ĐX2008-09. Mặc dù, bón phân theo SSNM cao hơn FFP gần 1,1 triệu đồng/ha. Cùng một mức phân (FFP), gia tăng mật độ cây (40+80)x22 cm, năng suất bắp cao hơn (75x20 cm) là 0,26 t/ha trong vụ HT2008.