Research article

Pre-Rice or Post-Rice Mungbean Productivity with Chemical and Bio-Compost Fertilizer under Rainfed Conditions

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Received 16 December 2014 Accepted 31 May 2015 (*Corresponding Author)

Abstract The objective of this research was to investigate the effect of chemical and bio-compost fertilizer application on growth and yield of mungbean when grown as pre-or post-rice under rainfed conditions, as well as economic return of growing mungbean. A randomized complete block design (RCBD) was used, with four fertilizer application treatments; soil applied as basal NPK, folia applied chelate EDTA compound, folia applied bio-compost and control. The results showed that soil applied NPK produced the maximum seed yield when mungbean grown as pre-or post-rice crop. In economic return, soil applied as basal NPK provided the maximum net benefit (565US $/ha) when mungbean grown as pre-rice crop. While, folia applied bio-compost gave the highest net benefit (295US $/ha) mungbean grown as post-rice crop.

Keywords mungbean, chemical fertilizer, bio-compost fertilizer, chelate EDTA compound, rice-based cropping systems

INTRODUCTION

Mungbean (*Vigna radiata* L.) is an excellent source of high quality protein (25%). It has also proved to be an ideal crop for pre-rice or post-rice crop in early and late rainy season with the short maturing, legume crop (Choudrary et al., 2011). Northeast Thailand is generally considered to have rice fields with particularly infertile soils with coarse texture (Wade et al., 1999). Mungbean is a high responsive to nutrients (Choudrary et al., 2011). Hence, nutrients requirement of mungbean can be met by supplying nutrients through chemical fertilizers, organic manures and bio-fertilizers with different application methods such as application to soil, seed priming and foliar application. Numerous studies have shown the usefulness of spraying micronutrients on grain crops (Schnappinger et al., 1969; Agrawal, 1992; Modaihsh, 1997). However the information on use of bio-compost to improve productivity of mungbean is neglected. The objective of this research was to investigate the effect of chemical and bio-compost fertilizer application on growth and yield of mungbean when grown as pre-rice or post-rice crop under rainfed conditions.

METHODOLOGY

Field experiments were conducted during May to July 2014 for pre-rice mungbean and December 2013 to March 2014 for post-rice mungbean. Rainfed lowland rice in Northeast Thailand is commonly sloping land, which determines groups of paddy land type, upper, medium and lower fields. Pre-rice mungbean crop grown in the upper field, while post-rice mungbean crop grown in the lower field. Since, the upper fields have a low chance of encountering to waterlogging condition with rainfall intensity during the early wet season. For the lower fields, stored soil water at the end of wet season may be sufficient for a quick maturing legume crops. The soil was sandy in texture of upper fields with pH (5.05), total N (0.025%), available P (7.02 mg/kg), exchangeable K (16.78 mg/kg) and organic matter (0.544%). For lower fields, soil was sandy loam in texture with pH (5.55), total N (0.022%), available P (6.81 mg/kg), exchangeable K (52.44 mg/kg) and organic matter (0.234%). Bulk density value average at 0-15 cm soil depth was about 1.61 and 1.45 g/cm^3 for pre and post-rice mungbean plots at planting, respectively.

The treatments consist of four fertilizer application; soil applied as basal NPK of fertilizer grade 15-15-15 (N - P_2O_5 – K_2O) at rate of 156 kg/ha, folia applied chelate EDTA compound at rate of 2 gm/liter of water, folia applied bio-compost (producing from pig placenta) at rate of 10 cc/liter of water. Bio-compost were analyzed for total N 3.8%, total P 0.15% and total K 0.78%. Soil applied as basal dose just before seed sowing. Folia Chelate EDTA (micronutrients) and bio-compost were sprayed to the crop at 15, 30 and 45 days after planting (DAP). Zero-tillage was practiced for post-rice mungbean and conventional tillage was used for pre-rice mungbean. The mungbean cultivar Chainat 72 was seeded in December 17, 2013 and May 15, 2014 with spacing 50 cm × 20 cm between row and plant. The mungbean crops were thinned to two plants per hill at 10 DAP. Weed control was done by hand once at 15 DAP in pre-or post-rice mungbean crop. No pesticide was used in pre-rice mungbean crop.

Data on top dry weight (stem + leaf) were recorded by drying samples in an oven at 60 °C for 72 h. The pods number per plant, seeds number per pod, 100 seeds weight and seed yield were measured at harvest. The nutrient concentration of mungbean leaf was determined for N, P and K at flowering in pre-rice mungbean crop. The nutrient uptake was calculated by leaf dry weight (kg/ha) x concentration (%) and divided by 100 for N, P and K uptake.

Soil moisture content was determined by gravimetric measurements at 0-15, 15-30 and 30-45 cm depth. Field capacity (FC) and Permanent Wilting Point (PWP) were estimated with pressure plate equipment. The crop received rainfall about 26 mm in December 2013 at 5 DAP. Later, rainfall did not occur in the entire the growing period when mungbean grown as post-rice crop. Soil moisture content observed which close to PWP at 45 DAP until harvest (Fig.1). The minimum air temperature during the growing period was about 14.5, 13.7 and 19.2°C in December 2013, January and February 2014, respectively. When mungbean grown as pre-rice, the crop received rainfall about 257 mm. Soil moisture content was observed in available range (FC and PWP) throughout the growing period (Fig. 2). The minimum air temperature was recorded about 25.0, 25.8 and 24.7 °C in May, June and July 2014, respectively.

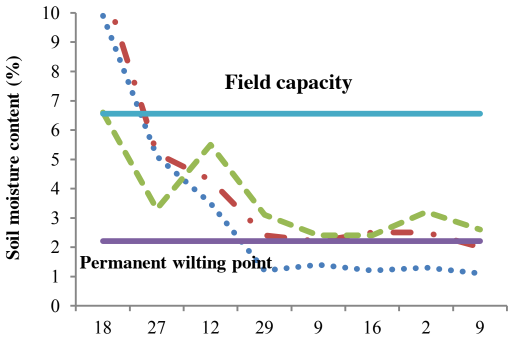

Fig. 1 Soil moisture content (%) at 0-15 cm (●●●), 15-30 cm (-·-) and 30-45 cm (- - -) depth during the growing period in post-rice mungbean

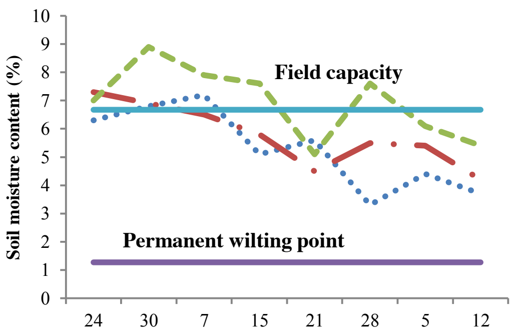

Fig. 2 Soil moisture content (%) at 0-15 cm (●●●), 15-30 cm (-·-) and 30-45 cm (- - -) depth during the growing period in pre-rice mungbean

RESULTS AND DISCUSSION

Growth, Yield and Yield Components of Mungbean at Harvest

Fertilizer application was not significantly affected on pod number per plant, seed number per pod and 100 seeds weight, but it was significantly difference on top dry weight and seed yield of mungbean when mungbean grown as pre-rice crop (Table 1). The maximum top dry weight and seed yield were obtained in soil applied NPK treatments.

Fertilizer application had no significant effect on top dry weight and pod number per plant, but had significant effect on seed number per pod, 100 seeds weight and seed yield of mungbean when grown as post-rice crop (Table 2). The soil applied NPK treatments produced maximum seed number per pod, 100 seeds weight and seed yield of mungbean.

Table 1 Growth, yield components and yield of mungbean at harvest as affected by fertilizer application when grown as pre-rice crop

Treatment	Top dry weight per plant (g)	Pod no. per plant	Seed no. per pod	1000 seed weight (g)	Seed yield (kg/ha)
Control	11.8 b	9.6	5.7	8.2	427.1 c
Soil applied NPK	19.8 a	13.9	7.4	8.5	666.9 a
Folia applied chelate	18.4 a	12.4	7.1	8.1	571.7 b
Folia applied bio-compost	16.7 ab	11.5	6.3	8.0	566.2 b
F-test	*	ns	ns	ns	*
CV (%)	23.3	24.4	22.4	8.1	11.6

*NS = Not significant, * Significant at $P < 0.05$*
Mean followed by the same letter at the same column was not significantly difference by LSD.

Table 2 Growth, yield components and seed yield of mungbean at harvest as affected by fertilizer application when grown as post-rice crop

Treatment	Top dry weight per plant (g)	Pod no. per plant	Seed no. per pod	1000 seed weight (g)	Seed yield (kg/ha)
Control	4.4	4.4	5.1 c	8.3 b	229.8 c
Soil applied NPK	5.5	6.1	7.4 a	8.9 a	324.7 a
Folia applied chelate	4.6	5.6	6.7 b	8.6 ab	276.8 b
Folia applied bio-compost	4.6	5.3	6.6 b	8.6 ab	273.4 b
F-test	ns	ns	*	*	*
CV (%)	13.4	17.2	3.5	36.	7.5

*NS = Not significant, * Significant at $P < 0.05$*
Mean followed by the same letter at the same column was not significantly difference by LSD.

Table 3 Nutrient concentration in leaves and nutrient uptake of mungbean at flowering as affected by fertilizer application when grown as pre-rice crop

Treatment	Concentration (%)			Nutrient uptake (kg/ha)		
	N	P	K	N	P	K
Control	4.10	0.322	2.30	36.3 b	2.8 b	19.3 b
Soil applied NPK	5.26	0.361	2.49	86.6 a	6.1 a	43.8 a
Folia applied chelate	4.73	0.335	2.34	66.1 ab	4.6 ab	31.6 ab
Folia applied bio-compost	4.41	0.336	2.28	46.5 b	3.6 b	21.5 b
F-test	ns	ns	ns	*	*	*
CV (%)	13.0	9.9	8.9	25.3	26.1	32.4

*NS = Not significant, * Significant at $P < 0.05$*
Mean followed by the same letter at the same column was not significantly difference by LSD.

Nutrient Concentration and Uptake of Mungbean at Flowering

Fertilizer application had no significant effect on N, P and K concentration of mungbean leaves at flowering when grown as pre-rice crop (Table 3). However, soil applied NPK tend to give the highest N, P and K concentration of mungbean leaves at flowering.

Fertilizer application was significantly affected on N, P and K uptake of mungbean leaves at flowering (Table 3). The maximum N, P and K uptake were recorded in the soil applied NPK treatments.

Economic Return of Growing Mungbean

All fertilizer application treatments provided good net income than control treatments. The maximum net benefit was obtained in soil applied NPK treatments when mungbean grown as pre-rice crop, while the highest net benefit was observed in folia applied bio-compost treatments when mungbean grown as post-rice crop (Tables 4 and 5).

Table 4 Yield, gross income, production cost and net income of mungbean when grown as pre –rice crop by different fertilizer application

Treatment	Yield (kg/ha)	Gross income (US $/ha)	Production cost (US $/ha)	Net income (US $/ha)
Control	427.1	533.9	175.8	358.1
Soil applied NPK	666.9	833.6	268.6	565.0
Folia applied chelate	566.2	707.8	203.9	503.9
Folia applied bio-compost	571.7	714.6	182.9	531.7

Note : Planting material = mungbean seed 50 baht/kg, NPK 19 baht/kg, chelate EDTA compound 400 baht/kg and bio-compost 20 baht/liter; Market price of mungbean seed 40 baht/kg; 1 US $ = 32 Thai baht; Production cost = Material cost + land preparation for mungbean growing; Household labor is considered as farming labor

Table 5 Yield, gross income, production cost and net income of mungbean when grown as post –rice crop by different fertilizer application

Treatment	Yield (kg/ha)	Gross income (US $/ha)	Production cost (US $/ha)	Net income (US $/ha)
Control	229.8	287.3	39.1	248.2
Soil applied NPK	324.7	405.9	131.9	274.0
Folia applied chelate	276.8	346.0	67.2	278.8
Folia applied bio-compost	273.4	341.8	46.2	295.6

Note : Planting material = mungbean seed 50 baht/kg, NPK 19 baht/kg, chelate EDTA compound 400 baht/kg and bio-compost 20 baht/liter; Market price of mungbean seed 40 baht/kg; 1 US $ = 32 Thai baht; Production cost = Material cost + land preparation for mungbean growing; Household labor is considered as farming labor

In pre-rice mungbean, soil applied NPK produced the maximum seed yield. However, all fertilizer application treatments gave higher seed yield than the control treatments. The soil applied NPK produced the maximum seed yield due to better plant development through nutrient uptake, where primary growth elements were available in sufficient amount. The obtained results are in agreement with the findings of Graham and Ascher (1993).

The sufficient N, P and K concentration in leaves of legumes crops at flowering stage was about 5.1%, 0.4% and 2%, respectively (Makay and Leefe, 1962). In this study, The N, P and K of leaves at flowering stage in soil applied NPK treatments were 5.26%, 0.361% and 2.49%, respectively. This indicates that N, P and K in soil provided an adequate amount for mungbean growth at flowering stage in soil applied NPK treatments.

Folia application of chelate EDTA increased seed yield over control. This agree with research work by Modaihsh (1997) and Mondal et al. (2011). Similarly, folia spray of bio-compost fertilizer produced higher seed yield than in control, due to better in plant growth. This agree with study by Buasri et al. (2010).

In post-rice mungbean, soil applied NPK also gave the highest seed yield. However, all fertilizer application treatments produced higher seed yield than the control. This was due to fertilizer application provided better shoot growth and subsequently produced good quality of all yield components. Soil application NPK as well as folia sprays of chelate EDTA and bio-compost supplemented availability of nutrients to mungbean crop. This agree with many research works by Graham and Ascher (1993); Ali et al. (2008); Modaihsh (1997) and Thalooth et al. (2006).

Mungbean seed yield in post-rice crop was lower than in pre-rice crop. This was due to post-rice mungbean the crop subjected to water stress at pod formation growth stage. This caused the highest reduction of pods number per plant. Similarly results were also reported by Thalooth et al. (2006). In addition the mungbean suffered from low temperature (below 15 °C) at seedling growth stage during December 2013 to January 2014. The temperature recorded below 15 °C may inhibited mungbean seeding growth was reported by DOA (2000).

CONCLUSION

All fertilizer application treatments produced higher seed yield than control. The soil applied as basal NPK gave the highest seed yield when mungbean grown as pre-rice or post-rice crop. However, in economic return the soil applied NPK provided the maximum net benefit when mungbean grown as pre-rice crop. While, folia applied bio-compost gave the highest net benefit when mungbean grown as post-rice crop. The results of those studies also suggested that mungbean is suitable to grow as pre-rice rather than post-rice crop.

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