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Performance of baby corn (*Zea mays* L.) under the influence of *in situ* green manuring and phosphorus in acid soil of Meghalaya

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Baby corn (*Zea mays* L.) is dehusked maize ear harvested within 2-3 days of silking, *i.e.* prior to fertilization. Being a short duration crop, it fits easily in an intensive cropping system. Depending upon the agro climatic conditions, 3 to 4 crops of baby corn can be taken up in a year with good profit and in addition to baby corn; it provides palatable green fodder to cattle. Baby corn crop, owing to its more profitability than grain maize, may be helpful in raising the income of the farmers of the North East region. Phosphorus is an essential element required for the growth of plants. It is an integral part of nucleic acid and plays a fundamental role in metabolism of fats, protein and starch. Despite its wide distribution in nature, P is a limited resource for plant growth and its low availability is a major constraint to crop production in acid soils (Redel *et al*., 2011). P fixation is the most limiting factor in acid soil particularly in the North Eastern region of India and P fertilizers are required to sustain optimum crop yields. Green manure has the ability to utilize the inaccessible fraction of phosphorus and make it available for crops. It is an important tool to improve soil fertility by enhancing organic carbon, nitrogen and other nutrients in available form in soil and lead to sustainable crop production (Fageria, 2007). The combined use of green manure with inorganic source of P fertilizer will increase the availability of phosphorus due to dissolution of sparingly soluble P sources and reduced P retention (Bah *et al*., 2006). Hence the present investigation was carried out to study the combined effect of green manure and phosphorus on the performance of baby corn.

An experimental trial was conducted in 2012 at the research farm of College of Post Graduate Studies, CAU, Umiam situated at 91p 54.73' E longitude and 25p 40.91' N latitude at an altitude of 950 m above the mean sea level, Meghalaya, India. The soil was acidic (pH 4.95) in nature with sandy clay loam texture. The organic carbon, available nitrogen, phosphorus and potassium were 0.77%, 282.24 kg ha^{-1}, 13.04 kg ha^{-1}and 241.98 kg ha^{-1}, respectively. The field experiment was laid out in split plot design with four replications. Main plots comprised of 2 levels *i.e.* without (G_1) and with green manuring (G_2) with ricebean (*Vigna umbellata* (Thunb.) Ohwi and Ohashi and sub plots included three levels of phosphorus *i.e.* 0 (P_0), 30 (P_1) and 60 (P_2) kg P_2O_5 ha^{-1} supplied through single super phosphate (SSP). A common dose of nitrogen and potassium @ 80 and 40 kg ha^{-1} through urea and muriate of potash (MOP), respectively were applied to the crop. Ricebean was sown along with the baby corn and was incorporated at 61 DAS. The nutrient composition of ricebean while incorporating is given in table 1.Plant height of 10 randomly selected plants were taken from the base of the plant to the tip of the leaf and then averaged. The leaf area of baby corn plant was obtained by using graph paper method. The leaf area index (LAI) was calculated by diving the leaf area per plant (cm^2) by the spacing (cm^2) (Watson, 1952). Chlorophyll content in plant was measured by using hand held dual wavelength meter (SPAD 502, chlorophyll meter, Japan). The data of the morphological characters were collected at silking stage. Physiological parameters like crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR) were by the formula proposed by Watson, (1952), Blackman, (1919) and Beadle, (1987), respectively. In order to calculate the baby cob yield and fodder yield per plot, the border plants from border rows were discarded and the yield was calculated per net plot in kg and then converted into t ha^{-1}. The harvest index (HI) was calculated by dividing the economic (grain) yield by biological yield (grain + fodder) and expressed in percentage. N and P and K contents (%) in plant samples were determined by modified kjeldahl method, colorimetric method and flame photometer method, respectively as described

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Table 1: Nutrient composition in ricebean at the time of incorporation

Phosphorus levels	Fresh weight (t ha^{-1})	Dry weight (t ha^{-1})	N content (%)	Pcontent (%)	K content (%)
P_0 (0 kg ha^{-1})	1.59	0.24	2.18	0.18	0.50
P_1 (30 kg ha^{-1})	2.09	0.32	2.23	0.21	0.64
P_2 (60 kg ha^{-1})	2.78	0.45	2.32	0.24	0.81

Table 2: Effect of green manuring and phosphorus on plant height, LAI and chlorophyll content

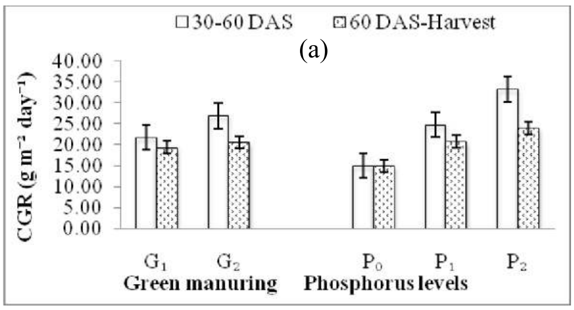
	Plant height (cm)	LAI	Chlorophyll (mg cm^{-2})
Green manuring			
Without green manure	159.69	2.52	7.74
With green manure	175.84	3.11	8.09
SEm(±)	3.14	0.06	0.07
LSD(0.05)	14.14	0.29	0.30
Phosphorus levels (kg ha^{-1})			
0	149.46	2.22	7.60
30	169.01	2.94	7.92
60	184.83	3.28	8.23
SEm(±)	**3.06**	**0.08**	**0.08**
LSD(0.05)	**9.42**	**0.25**	**0.26**

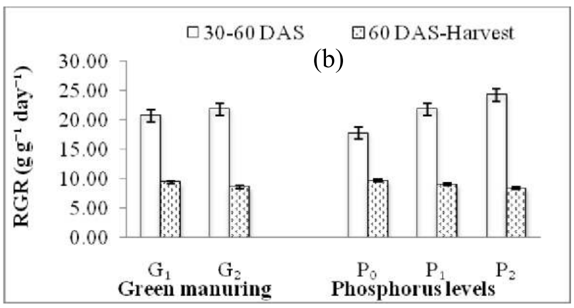
Table 3: Effect of green manuring and phosphorus on baby cob yield, fodder yield and harvest index

	Baby cob yield (t ha^{-1})	Fodder yield (t ha^{-1})	Harvest index(%)
Green manuring			
Without green manure	2.59	18.54	12.10
With green manure	3.12	20.53	13.08
SEm(±)	**0.04**	**0.28**	**0.19**
LSD(0.05)	**0.18**	**1.24**	**0.86**
Phosphorus levels (kg ha^{-1})			
0	2.19	16.84	11.48
30	2.72	19.22	12.36
60	3.64	22.55	13.93
SEm(±)	**0.07**	**0.31**	**0.33**
LSD(0.05)	**0.21**	**0.96**	**1.01**

by Jackson (1973). Protein content (%) was obtained by multiplying the nitrogen content by 6.25. The phosphorus content (%) in baby cob was multiplied by the corresponding dry matter yield to estimate the phosphorus uptake (kg ha^{-1}). The data were subjected to analysis of variance (ANOVA) and test of significance of the treatment difference was done on the basis of 't-test' and the means were separated using least significance difference (CD) at 5% probability level. The data was analyzed using STAR 2.0.1.

Plant height, LAI and chlorophyll content at silking stage were significantly influenced by green manuring (Table 2). LAI of 3.11 was obtained with green manure which was 23.77% higher over without green manure. Green manuring improved the moisture content in soil. Hence, the higher moisture availability might have enhanced the supply of mobile ions of nitrogen from soil to the roots and increased the nitrogen content of plants that reflected increased chlorophyll content in leaves. The chlorophyll content was 1.05 times higher with green manuring over without green manuring. With increase in the levels of phosphorus the morphological characters increased which might be attributed to a stronger role of phosphorus in cell division, cell expansion and enlargement which ultimately led to the vegetative growth (Bose *et al*., 2009). Higher chlorophyll content of 8.23 mg cm^{-2} was obtained with application of 60 kg P_2O_5 ha^{-1}. A reduction in LAI of 47.67% was observed with the application of P_0 from P_2 treatments. The reduced LAI at phosphorus deficient condition may be due to decreased cell production rate (Assuero *et al*., 2004), which ultimately reduced the photosynthetic efficiency of crops. Physiological parameters including CGR, RGR and NAR tended to increase with advancement of growth stage till 60 DAS and later on declined which may be due to decrease in leaf area and dry matter production (Fig.1a, 1b and 1c). CGR was significantly influenced by green manuring at 30-60 DAS (26.94 g m^{-2} day^{-1}) and gave significantly higher results over without green manuring (21.81 g m^{-2} day^{-1}). Significant increase in CGR in both 30-60 DAS and 60 DAS-harvest was found with increasing level of phosphorus due to increase in leaf area. Maximum RGR was observed at 60 kg P_2O_5 ha^{-1} (24.21 mg g^{-1} day^{-1}) which was significantly higher over control (17.76 mg g^{-1} day^{-1}). The increase in NAR in the early growth period was probably due to the increase in leaf area which was maximum at 60 DAS. On the contrary, the decrease in NAR with advancement in time might be due to mutual shading of leaves that resulted in lower photosynthetic efficiency or due to the senescence of leaves (Salam *et al*., 1987).





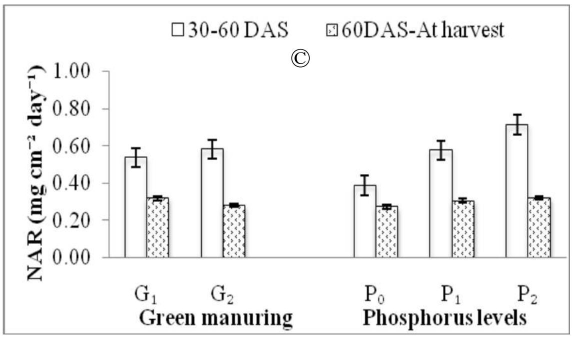
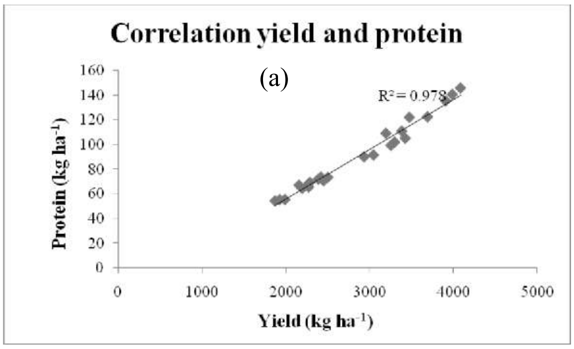


Fig. 1: Effect of green manuring and phosphorus levels on (a) CGR, (b) RGR and (c) NAR

The NAR at 30-60 DAS with P_0, P_1 and P_2 were 0.39, 0.57 and 0.71 mg cm^{-2} day^{-1}, respectively. Baby cob yield was significantly influenced by green manuring (3.12 t ha^{-1}). The substantial increase in yield with incorporation of green manure was due to its multiple effects such as supplying secondary and micronutrients, improving moisture availability and increasing the soil pH. Baby cob yield increased significantly with increase in phosphorus levels. Maximum yield was recorded at 60 kg P_2O_5 ha^{-1} *i.e.* 3.64 t ha^{-1} which were 1.34 and 1.67 times higher than 30 kg P_2O_5 ha^{-1} and control (Table 3) respectively. Green manuring enhanced the fodder yield by 10.71% over without green manuring. P fertilization showed positive effect on fodder yield. Augmentation in fodder yield upon application of 60 kg P_2O_5 ha^{-1} over the P_0 and P_1 treatments was 33.88% and 17.30%, respectively. Higher HI of baby corn with 60 kg P_2O_5 ha^{-1} (13.93 %) was probably due to increased P uptake and dry matter accumulation resulting from increased mobilization of P towards cob. The yield showed a highly significant correlation with protein and P uptake *i.e.* r^2 = 0.978 and 0.977, respectively (Fig. 2a and 2b). P uptake by cob in response to green manuring was 3.54 kg ha^{-1}. The uptake was lowest in the P_0 plot (2.01 kg ha^{-1}) while the highest was in P_2 (4.38 kg ha^{-1}) plot due to ready availability of nutrients. Higher protein content in cob (11.19 %) was observed due to green manuring signifying the positive effect of green manuring. Rising trend in protein content was found with increasing levels of phosphorus *i.e.* $P_2 > P_1 > P_0$.



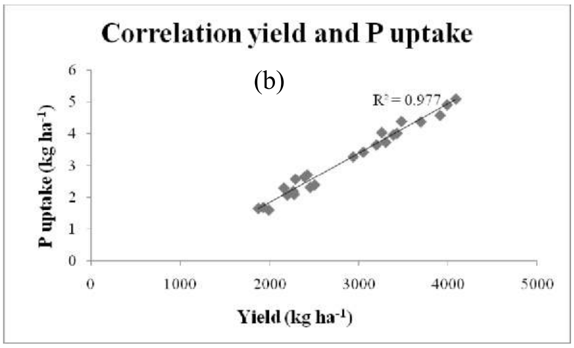


Fig. 2: Correlation between yield vs. (a) protein content and (b) phosphorus uptake

The results from the study suggested that the combined effect of green manure and mineral phosphorus fertilizer application enhanced the quality and yield of baby corn. The green manure influenced the assimilation of phosphorus from the fertilizer.

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