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Effect of integrated nutrient management on mungbean (*Vigna radiata*) under custard apple (*Annona squamosa*) based agri-horti system in Vindhyan region, Uttar Pradesh

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Agroforestry is recognized as a most diversified sustainable system to support the food and nutritional security, and is improving of the environment and country economy.It is a land use system which besides tangible benefits provides no tangible benefits like ecosystem services, *viz*. carbon sequestration, soil enrichment, biodiversity conservation and air and water quality (Jose *et al*. 2009). The benefits are compatible and complementary seek to emulate natural recycling mechanisms and other ecosystem services found in forests, promoting soil health and biodiversity that enhance production capacity (Nair *et al*. 2009). Alley cropping system is one of the important components of agroforestry in which the integration of fruit crops in crop lands is practiced (Ashoka *et al*. 2017). Fruit crop are first preference of farmers under agroforestry system on account of short gestation period, regular income, risk cover and aesthetic value. Alley cropping system in India markedly increases the growing season and the return per unit area per unit time. Custard apple (*Annona squamosa* L.) is distributed throughout the tropics and is pre-eminently a desert fruit. The nutrient value of custard apple (thiamine, potassium and dietary fibre) is also better for health. Mungbean [*Vigna radiata* (L.) Wilczek] is an important pulse crop which is fairly tolerant to drought and can be grown successfully in areas of erratic rainfall. Mungbean is an excellent source of protein (24.5%). Being a short duration crop, its fits well in various multiple and inter cropping systems (Dhakal *et al*. 2015). India is the world's largest pulse growing country which covers about 23.0 m ha area and producing about 25.23 m tons pulses with the productivity 694 kg/ha. In India, the area of mungbean is 2.93 m ha in 2016-17 with production of 2.01 m tonnes (DASE 2018).

On an average well decomposed farmyard manure (FYM) contains 0.5% N, 0.25% P_2O_5 and 0.5% K_2O. Organic carbon which improve the nutrient and water holding capacity of soils, increases nutrients availability, enhance the beneficial soil microorganism activity, improves the soil structure (Dhakal *et al*. 2016; Meena *et al.* 2020). Vermicompost is a rich source of essential plant nutrients and organic carbon to the soil which helps to release the nutrients slowly and improves physical, chemical and biological properties of the soil (Chhonkar 2002). In vermicompost, some of the secretions of worms and the associated microbes act as growth promoters. It is also rich in growth hormones, vitamins and acts as powerful biocide against diseases and nematodes (Giraddi *et al*. 2006; Meena *et al.* 2018). Biochar is a solid carbon-rich material prepared by the pyrolysis process of general biomaterials as charcoal for fuel. Biochar made by specific pyrolysis conditions for use in different environmental aspects. The physical and chemical characteristics of biochar give it several beneficial uses for environmental aspects, such as the soil improvement for planting (Kumar *et al*. 2018, Meena *et al.* 2020a). Climate change mitigation by waste management by conversion of biomass to biochar, and reducing CO_2 emission levels and storing it as carbon for a long time (Agegnehua *et al*. 2016). Biochar improve the soil quality by reducing the need for fertilizer use and acting as a nutrient pool for plants and increasing plant growth (Jindo *et al*. 2014). Pressmud used as organic fertilizer to increased soil health and crop production and also to mitigate the environmental

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pollution. These compost increases the quality of grains by increasing the protein and Ca contents to the soil (Kumar *et al*. 2018; Meena *et al.* 2020b). Biofertilizers helps in increasing availability of nitrogen and phosphorus besides increase in biological fixation of atmospheric nitrogen and enhance availability to crop (Pathak *et al*. 2001).Chemical fertilizers meet the nutrient requirement of the crop in very large amount. Therefore, there is an urgent need to reduce the usage of chemical fertilizers and in turn increase in the usage of organics which needed to improve the yield and quality levels (Ali *et al*. 2010).So an integration of organic and inorganic sources may improve the soil properties and may sustain the productivity.

The experiment was carried out at the Agricultural Research Farm, Rajiv Gandhi South Campus, Banaras Hindu University, Barkachha, Mirzapur (UP) which is situated in *Vindhyan* region of District Mirzapur. Geographically, experimental site falls under the sub-tropical zone and located on 25º 10'N latitude 82º 37' E longitude and an altitude of 427 m above mean sea level.The soil of the experimental field was acidic and sandy loam in texture with low drainage. Soil samples were air dried, gently ground and passed through 2mm sieve**.** The plow layer contains available N (228.63 kg/ha), P (21.97 kg/ha), K (245.38 kg/ha), organic carbon (0.37%), soil pH (5.61) and electrical conductivity (0.01 dS/m). The field experiment was laid out during *kharif* season of 2017 in 8 year old custard apple (*Annona squamosa* L.) orchard which was planted in at a spacing of 5 x 5 meter. Mungbean (*Vigna radiata* (L.) Wilczek) was sown as an intercrop. The experimental trial conducted in simple randomized block design with four replications and six different treatments: 75% RDF+ *Rhizobium*, 75% RDF+ Biochar+ *Rhizobium*, 100% RDF+ *Rhizobium*, 75% RDF + FYM+ *Rhizobium*, 75% RDF+ Vermicompost+ *Rhizobium*, 75% RDF + pressmud+ *Rhizobium*. The variety of mungbean used in experiment was HUM 12 (Malaviya Janchetna) @ 30 kg/ha. Recommended dose of fertilizer was applied @ 20, 40 and 20 kg N, P_2O_5 and K_2O /ha. The whole amount of nitrogen, phosphorus and potassium were given through urea, DAP and MOP, respectively. The required amount of fertilizers were calculated as per the treatment combination for each plot separately and were applied just before sowing in furrow opened by spade below the near about 7 cm deep. The organic sources were applied according to the treatments before 15 days of sowing, chemical composition were analysed as per the standard procedure Table 1.

The sources of NPK were Urea, DAP, MOP. The seed were sown manually in the furrow opened by *kudal* at a row distance of 30 cm as per treatment. In order to test the significance of variation in experimental data obtained from various treatment effects, data were statistically analyzed by standard statistical procedure (Gomez and Gomez 1976).

Table 1 Chemical composition of composts

Compost	Organic carbon (%)	Nitrogen (%)	Phosphorus (%)	Potassium (%)
Pressmud	38.25	1.97	2.66	0.66
Biochar	49.1	1.10	0.15	0.20
Vermicompost	8.6	2.3	4.5	0.4
FYM	0.98	0.5	0.2	0.5

A critical examination of data presented in Table 2 indicated that among the nutrient sources, the significantly highest plant height (49.88 cm), dry matter accumulation (10.26 g/plant) and LAI (3.93) at harvest, trifoliate leaves/ plant (14.13) and chlorophyll content (48.76 SPAD value) at 45 DAS, root nodules/plant (58.51 at flower initiation and 77.81at peak flowering), dry weight of root nodules (mg/plant) (35.81 at flower initiation and 49.55 at peak flowering) was observed with the application of 75% RDF + pressmud+ *Rhizobium* than other nutrient sources. While the applications of 75% RDF+ vermicompost + *Rhizobium* was found statistically at par. A significant increase in all the growth parameters may be due to application of 75% RDF + pressmud+ *Rhizobium* facilitated adequate availability of NPK, coupled with satisfactory moisture condition in field might have improved nutrient supplying capacity of soil (Ali *et al*., 2010). Good stand and better plant vigour indicates proper and balanced utilization of these nutrients by the crop. The increased availability of phosphorus to plant might have enhanced early root growth and cell multiplication which leads to more absorption of other nutrients from deeper layers of soil ultimately resulting in increased plant growth (Chattopadhyay and Dutta 2003). The pressmud+ *Rhizobium* play an important role in root development and proliferation resulting in better nodules formation and nitrogen fixation by supplying assimilates to the root (Singh and Pareek 2003). They also increase the CEC, water holding capacity and phosphate availability in soil thus provide better environment in rhizosphere for growth and development (Singh *et al*. 2010).

Results presented in Table 3 indicated that significantly highest length of pod (8.89 cm), number of pods/plant (12.87), number of seeds/pod (10.74), seed index (2.78 g), seed yield (580.75 kg/ ha), straw yield (1390.90 kg/ ha), biological yield (1971.65 kg/ ha) was observed with the application of 75% RDF + pressmud + *Rhizobium* than other nutrient sources. While the applications of 75% RDF+ vermicompost + *Rhizobium* was found statistically at par. The combined application of 75% RDF + pressmud+ *Rhizobium* to the mungbean increased availability of essential nutrients to plant due to enhanced early root growth and cell multiplication (Rathore *et al*. 2007). Pressmud+ *Rhizobium* being a store house of all the plant nutrients thus, the improvement in soil environment encouraged proliferation of plant roots, which helped to draw more water and nutrients from larger area and deeper layers which in turn increased vegetative growth owing to higher availability of nutrients, and more synthesis of carbohydrates and their translocation to different plant parts including the reproductive structures (Pandya and Bhatt 2007). Organic matter also function as a source of energy for soil micro flora which bring about the transformations of inorganic nutrients held in soil or applied in the form of fertilizers

Table 2 Effect of Integrated Nutrient Management on growth parameters of mungbean at different stages of growth

Treatment	Plant height (cm)		Dry matter accumulation (g/plant)		LAI		Trifoliate leaves/ plant	Chlorophyll content (SPAD value)	Number of root nodules/ plant		Dry weight of root nodules (mg/plant)	
	20 DAS	At harvest	30 DAS	At harvest	30 DAS	At harvest	45 DAS	45 DAS	flower initiation	Peak flowering	flower initiation	Peak flowering
75% RDF + *Rhizobium*	20.28	33.95	2.00	6.98	0.576	2.68	9.62	33.11	39.82	53.21	24.37	33.72
75% RDF + Biochar + *Rhizobium*	20.73	40.73	2.04	8.37	0.682	3.21	11.54	39.82	47.78	64.29	29.24	40.46
100% RDF + *Rhizobium*	21.59	43.07	2.13	8.86	0.721	3.40	12.20	42.11	50.53	67.19	30.92	42.79
75% RDF + Farmyard manure + *Rhizobium*	22.56	44.08	2.22	9.06	0.738	3.48	12.49	43.09	51.71	68.77	31.64	43.79
75% RDF + Vermicompost + *Rhizobium*	23.20	49.13	2.29	10.10	0.823	3.87	13.92	48.03	57.63	76.64	35.27	48.80
75% RDF + Pressmud + *Rhizobium*	23.55	49.88	2.32	10.26	0.835	3.93	14.13	48.76	58.51	77.81	35.81	49.55
SEm±	0.88	1.23	0.09	0.27	0.024	0.12	0.36	1.16	1.34	1.56	0.91	1.18
CD (*P*=0.05)	NS	3.70	NS	0.80	0.073	0.36	1.07	3.51	4.05	4.70	2.75	3.55

in a form that is readily utilized by growing plants (Suman *et al*. 2007).

Results indicate data presented in the Table 3 significantly highest gross return (83486 ₹/ha), net return (52872 ₹/ha) was observed with the application of 75% RDF + vermicompost + *Rhizobium* than other nutrient sources. While the applications of 75% RDF+ pressmud + *Rhizobium* was found statistically at par. While, the highest B: C ratio (1.86) was observed with the application of 100% RDF + *Rhizobium* (Table 3). While the applications of 75% RDF+ vermicompost + *Rhizobium* and 75% RDF + pressmud+ *Rhizobium* was found statistically at par.This may be ascribed to the beneficial role of pressmud+ *Rhizobium* in mineralization of native as well as applied nutrients in addition to their own nutrient content which increased the available nutrient pool of the soil; it will help to increase the marketable yield of the crop it is correlated with the economics of (Kumar *et al*. 2018).

SUMMARY

Agroforestry is recognized as most diversified sustainable system to support farmers income. In order to assess the effect of nutrient management system under agro forestry based cropping system, a field study was

Table 3 Effect of Integrated Nutrient Management on yield attributes yields and economics of mungbean

Treatment	Length of pod (cm)	No. of pods/ plant	No. of seeds/ pod	Seed index (g)	Seed yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Harvest Index	Net return (₹/ha)	Net return (₹/ha)	B: C ratio
75% RDF + *Rhizobium*	6.05	8.76	7.31	1.89	395.25	887.43	1282.68	31.64	71131	44376	1.66
75% RDF +Biochar + *Rhizobium*	7.26	10.51	8.77	2.27	493.25	1239.66	1733.41	29.59	78031	48751	1.67
100% RDF + *Rhizobium*	7.67	11.11	9.28	2.40	501.50	1251.23	1752.73	30.83	78510	51019	1.86
75% RDF + Farmyard manure + *Rhizobium*	7.85	11.37	9.49	2.45	513.25	1256.01	1759.26	29.29	79184	47404	1.49
75% RDF + Vermicompost + *Rhizobium*	8.75	12.67	10.58	2.74	572.00	1304.17	1876.17	30.49	83486	52872	1.78
75% RDF + Pressmud + *Rhizobium*	8.89	12.87	10.74	2.78	580.75	1390.90	1971.65	29.46	82652	52706	1.71
SEm±	0.25	0.30	0.32	0.08	6.98	11.17	11.16	0.50	442	441	0.05
CD (P=0.05)	0.76	0.90	0.97	0.24	21.04	33.66	33.63	NS	1331	1328	0.16

conducted during *kharif* season of 2017 on mungbean [*Vigna radiata* (L.) Wilczek] at the Agricultural Research Farm, Rajiv Gandhi South Campus, Banaras Hindu University, Barkachha, Mirzapur (UP). The experimental trial was conducted in simple RBD with four replications and six treatments, *viz*. 75% RDF+ *Rhizobium*, 75% RDF+ Biochar+ *Rhizobium*, 100% RDF+ *Rhizobium*, 75% RDF+ FYM+ *Rhizobium*, 75% RDF+ Vermicompost+ *Rhizobium* and 75% RDF + pressmud+ *Rhizobium*. Results revealed that highest growth parameters such as plant height, dry matter accumulation, leaf area index, trifoliate leaves, chlorophyll content, root nodules/plant and dry weight of root nodules and yield attributes and was observed with the application of 75% RDF + pressmud+ *Rhizobium* than other nutrient sources. Furthermore, highest gross return, net return was observed with the application of 75% RDF + vermicompost + *Rhizobium*. However, highest B:C ratio was observed with the application of 100% RDF + *Rhizobium*.

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