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Study of yield and economics of two different varieties of mung bean (*Vigna radiate* L.) at different NPK level under guava based agri-horti system in Vindhyan region

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Abstract
The experiment was conducted during *kharif* season of 2017 at the Agricultural Research Farm, Banaras Hindu University-South Campus, Uttar Pradesh. The experiment was laid out in a factorial randomized block design in guava based agri-horti system treatment which was replicated thrice. Inoculation of *Rhizobium* along with application of N (40 kg ha^{-1}) + P_2O_5 (50 kg ha^{-1}) + K_2O (40 kg ha^{-1}), recorded significantly higher grain and straw yield of green gram than the control. Two varieties were selected HUM-16 & SAMRAT .The highest net return of Rs 93901.03 ha^{-1} was recorded under inoculation of *Rhizobium* along with N (40 kg ha^{-1}) + P_2O_5 (50 kg ha^{-1}) + K_2O (40 kg ha^{-1}) with HUM-16 variety while minimum return Rs 75781.30 ha^{-1} was found in control. Higher benefit cost ratio 3.01was observed with N (40 kg ha^{-1}) + P_2O_5 (50 kg ha^{-1}) + K_2O (40 kg ha^{-1}) + *Rhizobium* with HUM-16. Application of N 40 kg ha^{-1} + P_2O_5 50 kg ha^{-1} and K_2O 40 kg ha^{-1} brought about 668.16 kg ha^{-1} of grain yield of variety hum-16 with 3.01 ratio of B:C.

Keywords: Agri-horti system, rhizobium, varieties, benefit-cost ratio

Introduction
Agroforestry is a dynamic and sustainable land management system of deliberately growing agricultural crops along with woody perennials on farmlands to secure both tangible and intangible benefits to the farmers. Agroforestry involves managing interactions between tree and non-tree components to produce diversified sustainable production system .India is the first country in the world to adopt the National Agroforestry Policy in 2014. Estimated land area of 1,023 million ha is under agroforestry worldwide.

Agri-horti system is an improved indigenous cropping system in India which fully utilizes the growing season and markedly increases the return per unit area per unit time. In this system we can increase the total output from land by growing mainly short duration crops within the alleys of such fruit crops. Tree based cropping system have proved to be very successful in areas receiving less than 1000 mm rainfall with nine months of dry season (Singh, 1989) [10]. Intercropping is one of the techniques of land utilization for optimum production (Bhattanagar *et al*., 2007) [3].

India produces 19.82 million tonnes of pulses from an area of 26.57 million hectares. However, about 5.6 million tonnes of pulses are imported annually to meet the domestic consumption requirement (Pattanayak, 2016) [8]. Pulses containing high protein (20-30%) are enormously utilized in covering widespread protein-calorie-malnutrition problem of the underdeveloped and developing countries including India.

Its seed contains 24.2% protein, 1.3% fat and 60.4% carbohydrate. It is a short duration crop and can be grown twice a year i.e. in spring and autumn seasons. The total area covered under mungbean in India is 30.41 lakh hectares with a total production of 14.24 lakh tones. The coverage of area and its production in maximum in Rajasthan (29.68% & 25.51% of the total area and production) while Maharashtra ranked second in area coverage (12.98%) and third in production (11.92%). The National yield average in 468 kg ha^{-1}. Among various factors, judicious use of fertilizer is of prime importance.

Mungbean, being a rich source of protein, needs to be judiciously fertilized with sulphur. It is considered critical for seed yield and protein synthesis and for improvement of quality of produce in legumes through enzymatic and metabolic effects (Bhattacharjee *et al*. 2013). Sulphur not only improves grain yield but also improves the quality of crops (Hegde and Babu, 2004; Hegde and Murthy, 2005, Mitra *et al.* 2006) [6, 5, 7]

Rhizobial actions and N fixation is down without appropriate application of P. It promotes early root development and the formation of lateral, fibrous and healthy roots, which is extremely significant for nodule formation and fixation of atmospheric N. It is reported that application of P along with *Rhizobium* inoculant influenced nodulation and N fixation of legume crops (Bhuiyan *et al*. 2008) [4]. Biofertilizers are known to play an important role in increasing biological fixation of atmospheric nitrogen and enhance phosphorus availability to crop (Bhat *et al*., 2013) [2]. Similarly, humus derived from vermicompost is most commonly used for sustainable production (Prem sekhar and Rajashree, 2009) [9] due to its beneficial effects on nutrient uptake and retention, pest control and productivity (Barrios *et al*., 2011) [1].

Material and Method

The experiment was conducted during *kharif* season of 2017 at the Agricultural Research Farm, Banaras Hindu Universit-South Campus, Mirzapur, Uttar Pradesh. The soil of the experimental field was sandy loam-silt in texture with pH 6.42. It was moderately fertile with organic carbon (0.29%), available nitrogen (203.36 kg ha^{-1}), available phosphorus (19.55 ha^{-1}) and available potassium (236.75 kg ha^{-1}). The experiment was laid out in a Factorial Randomized Black Design with three replications. guava based Agri-horti system. Treatment was replicated three times. The experiment consisted of 8 treatments *viz*. control, with SMRAT variety under N (20 kg ha^{-1}) + P_2O_5 (30 kg ha^{-1}) + K_2O (20 kg ha^{-1}), N (30 kg ha^{-1}) + P_2O_5 (40 kg ha^{-1}) + K_2O (30 kg ha^{-1}), N (40 kg ha^{-1}) + P_2O_5 (50 kg ha^{-1}) + K_2O (40 kg ha^{-1}) and with HUM-16 variety 0 kg N + 0 kg P_2O_5,0 kg K_2O ha^{-1}, N (20 kg ha^{-1}) + N (30 kg ha^{-1}) + P_2O_5 (40 kg ha^{-1}) + K_2O (30 kg ha^{-1}), N (30 kg ha^{-1}) + P_2O_5 (40 kg ha^{-1}) + K_2O (30 kg ha^{-1}) ha^{-1}, N (40 kg ha^{-1}) + P_2O_5 (50 kg ha^{-1}) + K_2O (40 kg ha^{-1}). The requisite quantity of seed at rate of 15 kg ha^{-1} was sown. A plant spacing of 10 cm within the row was maintained by thinning at 15 days after sowing. The seeds were sown directly with the help of *Kudal* at a distance of 30x10 cm. The experiment was carried out in ten years old guava trees planted at 7x7 meter spacing. Various observations were recorded during the course of investigation including morphological and yield attributes as affected by *Rhizobium* and fertility levels. Morphological studies particularly the growth parameters were recorded at various phenological stages starting from 20 DAS followed by 40 and at harvest.

Table 1: Effect of NPK and *Rhizobium* and variety on yield attributes of mungbean under guava based agri-horti system

Treatment	Yield attributes			
	Pod length (cm)	Pod plant^{-1}	Grain pod^{-1}	Test weight (g)
Fertilizer Levels				
F_0	6.53	17.57	6.19	31.79
F_1	7.47	20.74	7.34	33.36
F_2	8.75	22.86	8.02	34.87
F_3	9.67	24.58	9.25	37.65
S.Em. ±	0.26	0.48	0.35	0.56
CD at 5%	0.55	1.03	0.76	1.21
Varieties				
Samrat	7.87	21.13	7.19	33.32
HUM-16	8.34	21.73	8.21	35.51
S.Em. ±	0.18	0.34	0.25	0.40
CD at 5%	0.39	0.73	0.54	0.85
Fertilizer X Varieties	S	S	S	S

Table 2: Effect of NPK and *Rhizobium* and varieties on grain yield, straw yield, biological yield and harvest index of green gram under guava based agri-horti system

Treatment	Grain yield (Kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
Fertilizer Levels				
F_0	493.57	1715.98	2209.55	22.37
F_1	598.89	2016.68	2615.56	22.92
F_2	693.67	2202.02	2895.69	23.96
F_3	798.09	2477.82	3275.91	24.36
S.Em. ±	26.12	54.63	61.22	0.82
CD at 5%	56.02	117.16	131.30	1.75
Varieties				
Samrat	623.96	2039.56	2663.52	23.36
HUM-16	668.16	2166.69	2834.84	23.45
S.Em. ±	18.47	38.63	43.29	0.58
CD at 5%	39.61	82.85	92.84	1.24
Fertilizer X Varieties	S	S	S	NS

Result and Discussion

Data pertaining to grain yield of green gram as influenced by fertility levels with *Rhizobium* and varieties are presented in Table (2). A close examination of the data revealed marked effect of NPK with *Rhizobium* application on grain yield. Increasing levels of NPK application of 40 kg N, 50 kg P_2O_5, 40 kg K_2O ha^{-1} significantly increased the grain yield ha^{-1}, respectively. As regards the two green gram varieties, HUM-16 produced highest grain yield (668.16 kg ha^{-1}) followed by SAMRAT(623.96 kg ha^{-1}). Both the varieties differed significantly among themselves with respect to grain yield. Differences in straw yield were also observed with respect to both varieties. Green gram variety, HUM-16 produced highest yield and being proved significantly superior over SAMRAT. Significant differences in harvest index were observed due to varieties. Green gram variety HUM-16 produced highest harvest index followed by SAMRAT.

Relative Economics

The economic analysis includes the cost of cultivation, gross return, net return and benefit: cost ratio for different treatment, combinations, and the data in respect of economics have been summarized in Table 3.

Cost of cultivation (Rs ha^{-1})

The common cost of cultivation of different treatment combination were work out, considering all operation from land preparation to harvesting and input used. The treatment cost was calculated separately and it was combined with common cost of cultivation to find out the total cost of cultivation. Data revealed that the total cost of cultivation was maximum Rs. 23228 ha^{-1} for 40 kg N, 50 kg P_2O_5 and 40 kg K_2O ha^{-1} + with *Rhizobium* culture over the control and the rest of the treatments. The total cost of cultivation was minimum Rs. 19001 ha^{-1} under the control treatment. Where the factor of the variety Cost of cultivation was increased significantly with the variety HUM-16 over SAMRAT.

Gross return (Rs. ha^{-1})

It is evident from the data that among different fertility levels and inoculation of seed with *Rhizobium* recorded maximum gross return in alley cropping was Rs. 70673.03ha^{-1} due to 40 kg N, 50 kg P_2O_5 and 40 kg K_2O ha^{-1} with *Rhizobium* culture. The minimum gross return Rs. 56780.30 ha^{-1} was recorded in custard apple based cropping system under control treatment, respectively. Where the factor of the variety gross return was increased significantly with the variety HUM-16 over SAMRAT.

Net returns (Rs. ha^{-1})

The net return was markedly influenced due to different cost incurred and yield (grain and straw) obtained under various treatments. The maximum and minimum net return was recorded under application of 40 kg N, 50 kg P_2O_5 and 40 kg K_2O ha^{-1} with *Rhizobium* culture (Rs. 93901.03 ha^{-1}) and the control (Rs. 75781.30 ha^{-1}), respectively. Where the factor of the variety net returns was increased significantly with the variety HUM-16 over Samrat.

Table 3: Effect of NPK and *Rhizobium* and varieties on relative economics of mungbean under guava based agri-horti system

Treatment	Relative economics		
	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
Fertilizer Levels			
F_0	56780.30	75781.30	2.99
F_1	60671.78	82114.78	2.83
F_2	65368.67	87661.67	2.93
F_3	70673.03	93901.03	3.04
S.Em. ±	1442.68	1442.68	0.06
CD at 5%	3094.24	3094.24	0.14
Varieties			
Samrat	62043.49	83534.74	2.89
HUM-16	64703.40	86194.65	3.01
S.Em. ±	1020.13	1020.13	0.05
CD at 5%	2187.96	2187.96	0.10
Fertilizer X Varieties	S	S	S

Benefit: cost ratio

The data on benefit: cost ratio indicated that the maximum benefit: cost ratio of 3.01was recorded by the inoculation of *Rhizobium* culture with 40 kg N, 50 kg P_2O_5 and 40 kg K_2O ha^{-1} and HUM-16 variety followed by with 40 kg N, 50 kg P_2O_5 and 40 kg K_2O ha^{-1} and SAMRAT variety with *Rhizobium* culture respectively under custard apple based agri- horti system (Table 3) incurred the minimum benefit: cost ratio (2.89).

Conclusion

Based on the experimental findings, under guava based agroforestry system the inoculation of mungbean variety HUM-16 with *Rhizobium* (MOR-1) along with N 40 kg ha^{-1} + P_2O_5 50 kg ha^{-1} + K_2O 40 kg ha^{-1} proved more yielder. Application of N 40 kg ha^{-1} + P_2O_5 50 kg ha^{-1} and K_2O 40 kg ha^{-1} brought about 668.16 kg ha^{-1} of grain yield of variety HUM-16 and this treatment gave a maximum net return of Rs. 93901.03 ha^{-1} with 3.01 ratio of B:C.

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