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Evaluation of intercultural techniques on nutrient content, uptake and yield by grain and stover of rainfed green gram (*Vigna radiata* L.) under Agri-horti system

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Abstract
Agroforestry is a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. A field experiment was conducted at Agricultural Research Farm, BHU, Barkachha, Mirzapur, (U.P.). The experiment consisting of six intercultural techniques treatments was laid out in Randomized Block Design with four replications on sandy loam soil during *Kharif* season 2019. The treatments were Control (No interculture) (T_1), Rice straw mulch (2 tonnes ha^{-1}) (T_2), {T_2 + Pre-mergence herbicide (Pendimethalin @ 1.0 kg ha^{-1})} (T_3), Hoeing at 15 DAS (T_4), Hoeing at 30 DAS (T_5), Hand weeding @ 20 & 40 DAS (T_6). The Result revealed that the maximum N, P & K content (%) in grain noted with the treatment T_6 (weeding at 20 & 40 DAS). Two hand weeding (T_6) also remarked significantly higher N, P & K uptake by grain over other treatments. The significantly higher nutrient content (%) and uptake (kg ha^{-1}) in grain & stover, grain yield (920.75 kg ha^{-1}) and stover yield (1860 kg ha^{-1}) were also recorded under T_6 treatment.

Keywords: Straw, mulch, Agri-horti system, hand weeding, herbicide, hoeing

Introduction
Pulses are the cheapest source of quality protein for human being. The protein hunger is common problem in India, where majority populations have vegetative diet. It is well known that paucity of protein diet results in malnutrition. In general, pulses have two to three times more protein than the cereals or any other group of plants besides supply of micronutrients, low fat, high dietary fibre and complex carbohydrates. Green gram (*Vigna radiata* L.) belongs to family Fabaceae and commonly known as mungbean or golden gram. This crop is native of India and Central Asia and cultivated in Myanmar, Sri Lanka, Pakistan, China, Fiji, Queensland, Africa etc. In India it occupies an area of 3.70 million hectares, production of 1.60 million tonnes with an average productivity of 521 kg ha-1 (DES, 2015-2016) [6]. In India these crops are cultivated in three different seasons, *viz*., *kharif*, *Rabi* and *Zaid*. Mungbean covered an area of more than 3.0 million hectares with annual production of 1.60 million tons during 2015-16 growing season. The coverage of area and its production was maximum in Rajasthan (29.68% & 25.51% of the total area and production). Maharashtra ranked second in area coverage (12.98%) and third in production (11.92%). Andhra Pradesh ranked third in area (8.74%) and second in production (12.43%). The highest yield was recorded by the state of Punjab (838 kg/ha) followed by Jharkhand (680 kg/ha) and Tamil Nadu (675 kg/ha). The National yield average was 468 kg/ha. The lowest yield observed in the state of Karnataka (247 kg/ha) followed by C.G. (269 kg ha^{-1}) and Odisha (337 kg/ha), (DES, 2015-16) [6]. The losses of mung bean yield due to weeds ranges from 65.4% to 79.0% (Dungarwal *et al.* 2003) [7]. Arif *et al.* (2006) [2] reported that besides causing crop losses, weeds creating competition for nutrients, space, water etc. reduce the crop yield and the quality of produce hence; reduce the market value of the produce. Agri-horti system markedly increases the returns per unit of land mainly during early stage of horticultural fruit trees. In *Vindhyan* region of Uttar Pradesh growing of pulses, intercropped with custard apple, guava, bael, *Subabul* and *Karonda* etc. are more suitable under the agri-horti system. Hand and mechanical control methods are used on a large scale but, cost is very high, unfavourable weather and soil condition and also the labours are not available at proper time. Keeping all these points in view, the present research work entitled, Influence of intercultural techniques on growth & yield of rainfed green gram (*Vigna radiata* L.) under the custard apple (*Annona squamosa* L.) based Agri-horti system" was

undertaken at Agricultural Research Farm RGSC, BHU Barkachha, Mirzapur (U.P.).

Material and Methods

A field experiment was conducted on during kharif season of 2019 at south campus, Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh. The experiment site is located at 25^0 10' N latitude and 82^0 37' E longitude and at an altitude of 427 meters above mean sea level. This farm is spread over in an area of more than 1000 ha where several types of crops are raised. The experimental field soil was sandy clay loam with pH 6.48. The soil was low in available N 229.50 kg ha^{-1}, medium in available P (20.40 kg ha^{-1}) and available K (240.80 kg ha^{-1}). Bulk density (1.42 g cm^{-3}) and Particle density (2.63 g cm^{-3}) were recorded in 0-15 cm depth. The experiment was laid out in a Randomized block design with six treatments and four replications. The treatments were *viz.* Control (No Interculture) (T_1), Rice straw mulch (2 tones ha^{-1}) (T_2), (T_2 + Pre-mergence herbicide) (Pendimethalin @ 1.0 kg ha^{-1}) (T_3), Hoeing at 15 DAS (T_4), Hoeing at 30 DAS (T_5), Hand weeding @ 20 & 40 DAS (T_6). The green gram variety 'HUM-16'was sown on 21st July 2019 with the help of manual single row drill at 30 cm row spacing and using 15 kg seed ha^{-1} in 3 × 3 m^2 net plot size under the fourteen-year-old custard apple (*Annona squamosa* L.) plantation. Custard apple is one of the delicious and nutritious fruits can be grown in areas with rainfall as low as 400 mm. It was probably introduced into Australia from British Guiana. It is erect, with a rounded or spreading crown and trunk 10 to 14 inches (25-35 cm) thick. Height of the tree ranges from 15 to 35 feet (4.5-10 m) which is at a spacing of 5×5 m^2. Fertilizer was applied 15-40-15-10 NPKS kg ha^{-1} in the form of Di-ammonium phosphate, murate of potash and gypsum. The application of total quantity of fertilizers was applied as basal 5 cm below seed line at the sowing time. Pre-emergence application of Pendimethalin 30 EC was applied in respective treatment combinations with the help of flat fan nozzle attached to hand sprayer using volume of spray 1 kg ha^{-1} on day after crop sowing. Rice straw mulch was uniformly spread 10 days after sowing to reduce weed competition in respective treatments. All agronomic and cultural operations were followed for the success the crop. Collection of data, five representative plants were randomly selected from each net plot and tagged. These tagged plants were used to record biometric observations at different growth stages. The maturity of crop was judged by visual observation and was harvested at 67 DAS (28 September 2019), separately and stacked plot wise for sun drying and subsequent threshing. Grain and stover samples were analyzed for nutrient contraction as per the standard procedure. N, P and K uptake (kg ha^{-1}) were calculated by multiplying their nutrient (NPK) concentration with crop yield and divided by 100. The statistical analysis of data was worked out by the standard statistical method 'Analysis of Variance'. The significance of the treatment effect was tested with the help of 'F' test (Variance ratio). The difference of the treatments mean was tested using critical difference (C.D.) at 5% probability level. When the variance ratio (F test) was judged significant at 5% level, standard error of mean (S.Em+) was calculated with critical differences (CD) for comparison between two means.

Result and Discussion

Various intercultural techniques reflected noticeable effect on crop growth. The maximum N, P & K content (%) in grain noted with the treatment T_6 (weeding at 20 & 40 DAS) which was significantly superior over rest treatments except treatment T_3 (straw mulch + Pendimethalin @ 1 kg ha-1) which was at found par (Table 1). The lowest N, P and K content recorded under the treatment T_1 (no intercultural techniques). The N, P and K uptake by grain significantly varied due to the various treatments. The highest and the lowest N, P & K uptake by grain recorded were 28.09, 3.58, 12.49 and 10.39, 1.08 and 4.56 kg ha^{-1}, respectively under the T_6 (hand weeding at 20 & 40 DAS) and control treatment (T_1), respectively (Table 1). Two hand weeding (T_6) caused significantly higher N, P & K uptake by grain over other treatments and closely followed by the treatment T_3 and T_2..The significantly highest N, P & K content (%) in stover recorded under the treatment T_6 (hand weeding at 20 & 40 DAS) as compared to other treatments. The lowest nutrient content noted with the control treatment (T_1). The N, P and K content (%) and nutrient uptake by grain and stover showed significant variation due to different intercultural practices. Two hand weeding at 20 & 40 DAS recorded the highest nutrient content (3.05, 0.39, 1.35 NPK %) and nutrient uptake (28.09, 3.58, 12.49 NPK kg ha^{-1}) by grain and highest nutrient content (1.33, 0.26, 2.47 NPK %) and nutrient uptake (24.73, 4.83, 45.94 NPK kg ha^{-1}) by stover (Table 1). Effective control of weeds and reduced competition between crop and weeds is one of the important factor responsible for higher grain yield (920.75 kg ha^{-1}), stover yield (1860.00 kg ha^{-1}), biological yield (2780.75 kg ha^{-1}) and harvest index (33.08%) obtained under two hand weeding (20 & 40 DAS) treatment (T_6) (Table 2). It can be explained in light of the facts that better weed control minimized the nutrient loss towards weeds and more nutrients became available to crop, consequently improved concentration of nutrients and yield and higher uptake of nutrients by the green gram. Similar results were reported by Patel (2000) [11] in pigeon pea and Chauhan (2000) [3] in chickpea and Kaur *et al.* (2010) [9], Chhodavadia *et al.* (2011) [5], Chhodavadia *et al.* (2013) [5], Komal *et al.* (2015) [10] in green gram.

Table 1: Influence of different intercultural techniques on nutrient content and uptake by grain and stover in green gram

Treatment	Nutrient Content (%) in grain			Nutrient uptake (kg ha^{-1}) by grain			Nutrient Content (%) in stover			Nutrient uptake (kg ha^{-1}) by stover		
	N	P	K	N	P	K	N	P	K	N	P	K
T_1	2.30	0.24	1.01	10.39	1.08	4.56	1.05	0.12	2.12	13.96	1.60	28.19
T_2	2.68	0.34	1.26	21.37	2.70	10.04	1.22	0.19	2.32	21.08	3.28	40.08
T_3	2.97	0.37	1.30	25.38	3.15	11.12	1.26	0.22	2.39	22.58	3.94	42.84
T_4	2.63	0.32	1.23	20.06	2.44	9.40	1.19	0.17	2.23	19.68	2.81	36.88
T_5	2.50	0.30	1.23	18.83	2.25	9.24	1.13	0.15	2.19	18.30	2.43	35.47
T_6	3.05	0.39	1.35	28.09	3.58	12.49	1.33	0.26	2.47	24.73	4.83	45.94
SE±	0.04	0.01	0.02	0.32	0.02	0.11	0.01	0.01	0.01	0.05	0.01	0.03
CD (P=0.05)	0.11	0.03	0.07	0.98	0.05	0.33	0.03	0.04	0.03	0.16	0.05	0.11

Table 2: Effect of intercultural techniques on grain and stover yield (kg ha^{-1}) of green gram under custard apple based Agri-horti system

	Treatments	Grain yield (kg ha-1)	Stover yield (kg ha-1)
T1:	Control	452.00	1329.75
T2:	Straw mulch	797.50	1728.00
T3:	T2 + Pendimethalin	854.25	1792.75
T4:	Hoeing at 15 DAS	763.00	1654.00
T5:	Hoeing at 30 DAS	752.00	1620.00
T6:	Hand weeding at 20 & 40 DAS	920.75	1860.00
	S.Em+	4.03	6.20
	CD (P=0.05)	12.27	18.86

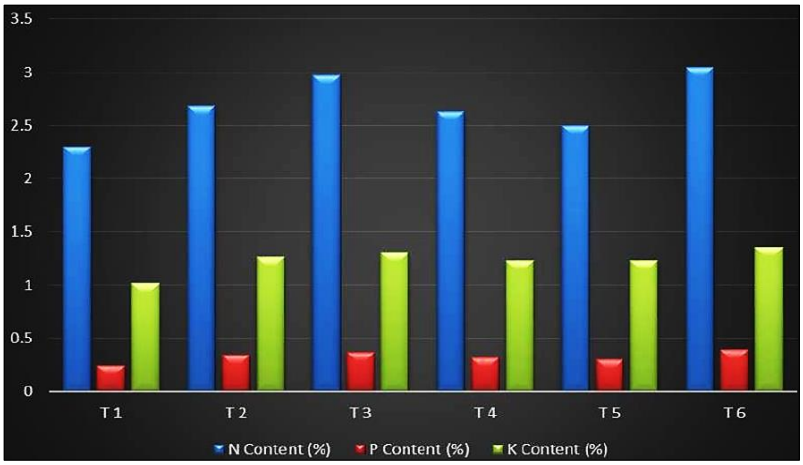

Fig 1: Effect of intercultural techniques on N, P & K content (%) in grain of green gram under custard apple based Agri-horti system

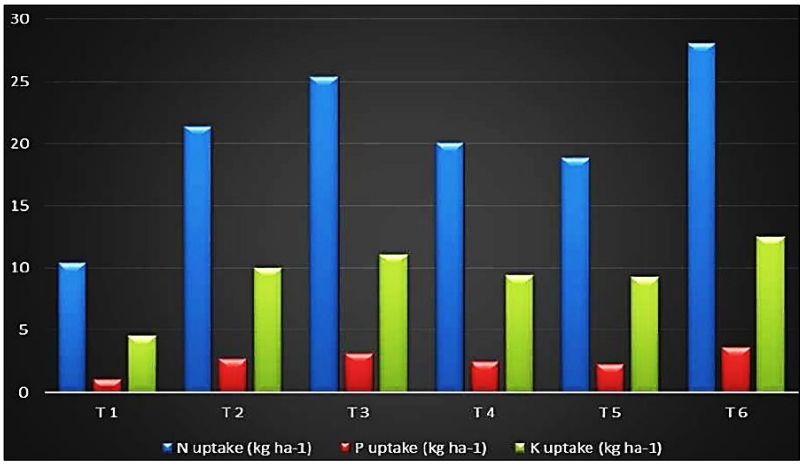

Fig 2: Effect of intercultural techniques on N, P & K uptake (kg ha^{-1}) by grain of green gram under custard apple based Agri-horti system

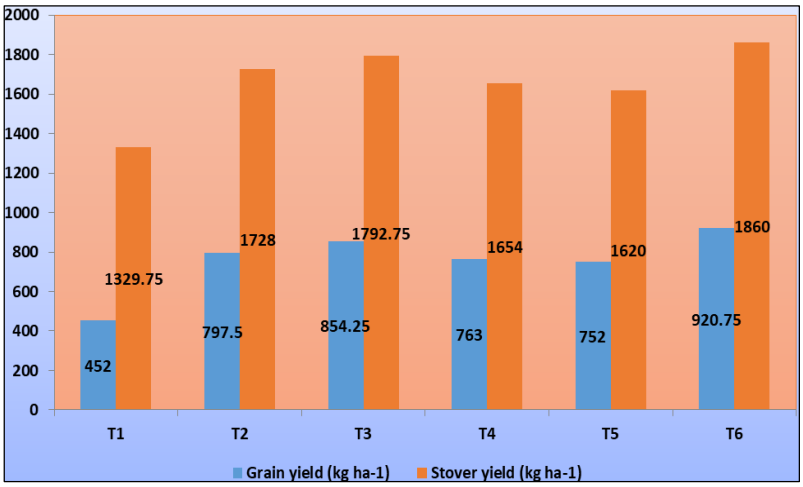

Fig 3: Effect of intercultural techniques on grain and stover yield (kg ha-1) of green gram under custard apple based Agri-horti system

Conclusion

It appears absolutely sensible to conclude with the fact that higher nutrient content (%) and uptake (kg ha^{-1}) in grain & stover has been one of the reason behind accounting significantly higher grain yield (920.75 kg ha^{-1}), stover yield (1860 kg ha^{-1}), biological yield (2780.75 kg ha^{-1}) and harvest index (33.08%), which can be achieved by following conventional method of two hand weeding at 20 and 40 DAS where labours are easily available. Alternatively integrated weed control method rice straw mulch + Pendimethalin 1 kg ha^{-1} pre-emergence can be adopted where farm labours are scarce, costly and timely unavailable.

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