



Response of N P S doses and urea foliar spray on lentil under guava (*Psidium guajava*) + lentil (*Lens culinaris*) based agri-horti system

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Vindhyan region, the place of experimentation is a hilly area that has some important limitations with respect to sole crop production system, include landscape being uneven, hilly acidic, less fertile, highly vulnerable to intensive tillage practices and poor income to the farmers. In view of these challenges, alley cropping may be an implementable sustainable option to the farmers for increasing productivity of rainfed land in Vindhyan region of eastern Uttar Pradesh. Guava (*Psidium guajava* L.) contributes 3.3% to India's total fruit production and covers around 3.3% of the total area planted under fruit crops. Lentil (*Lens culinaris* Medik.) is a major cool-season grain legume crop after chickpea (*Cicer arietinum* L.) in India. It has high protein content, which ranges from 20.6–31.4% (Urbano *et al.* 2007). Under rainfed conditions, basal application and foliar feeding of nutrients has been found to optimise crop yield. Field crops grown with agri-horticulture tend to have different nutritional requirements than the normal cropping pattern. Foliar application of nutrients has been shown as an important asset of fertilizer application with the specific aim of increasing nutrient availability when needed. Although foliar spray of trace elements has got the majority of attention, it has been regularly observed that foliar application of macronutrients also has a positive impact on plant metabolism and ultimately on yield (Niu *et al.* 2021). Urea as foliar feeding under rainfed condition may provide strength to crop plants to withstand moisture stress during winter (*rabi*) season. Foliar application (spray) of urea in adequate quantities improves steady photosynthetic rate and the nitrogen availability to developing seeds in pulses (Palta *et al.* 2005). Therefore, it is necessary to find out the appropriate time of urea spray and optimum doses of chemical fertilization for increasing its yield in guava +

lentil cropping system comparatively which is subjected to shading effect of guava.

Present study was carried out at research farm of Rajiv Gandhi South Campus, Barkachha, Mirzapur situated in eastern Uttar Pradesh during winter (*rabi*) season of 2021–22. The soil of experimental site was acidic sandy clay loam, low in organic carbon (SOC), nitrogen and phosphorous (0.34% 169.20 and 10 kg/ha, respectively), and medium in potassium content (181.20 kg/ha). During the trial period the average temperature, relative humidity and sunshine hours were 20°C, 64.5% and 5.6 h, respectively, with a total rainfall of 31.2 mm. Lentil variety Malviya Vishwanath: HUL 57 was grown in alleys (6857 m²) of 10 years old guava (var. Sardar L 49) plantation of 1 ha laid in split-plot design comprised of 12 treatments with 3 replications. The area sacrificed in a 1 ha guava orchard to avoid its shading effect on lentil, grown in alleys, to certain extent was 3143 m² but still 4057 m² (i.e. 59%) of 6857 m² was affected with the shading of guava branches. The main plot treatments comprised doses of nitrogen, phosphorus and sulphur (DNPS) N₀+P₀+S₀, N₂₀+P₄₀+S₂₀, N₂₀+P₅₀+S₃₀, N_{23.5}+P₆₀+S₄₀ and sub plot of 3 treatments as foliar spray (Water spray at pre-flowering (PF) stage (45 DAS), 2% urea at pre-flowering stage (45 DAS), 2% urea at pre-flowering stage (45 DAS) followed by (*fb*) by 2% urea at pod initiation (PI) stage (75 DAS). The required amount of nitrogen, phosphorus and sulphur were applied as basal application in various rows of crop. The source of N, P, K and S fertilizers were urea, DAP, MOP and sulphur WDG, respectively. Guava was planted at a spacing of 7 m × 7 m, whereas lentil was sown @30 kg/ha at spacing of 30 cm × 5 cm. The observations on the growth parameters of lentil, viz. number of green leaves/plant and number of root nodules/plant were recorded at 60 days after sowing (DAS) while plant height, number of branches/plant and dry matter accumulation/plant were recorded at 90 DAS and at harvest stage. Yield attributes and yield were recorded after harvest of test crop. The observations of growth attributes of guava,

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Table 1 Measurement of growth attributes of guava tree at the time of sowing and harvesting of lentil

Measurement of guava tree	Plant height (m)	Stem girth (m)	Canopy diameter (m)	Crown length (m)	Shading area	
					Length (m)	Width (m)
At the time of lentil sowing	5.20	0.360	5.57	4.03	3.61	3.06
At the time of lentil harvesting	5.48	0.373	5.60	4.24	3.96	3.22

viz. plant height, canopy diameter, girth, crown length and shading area of guava were recorded at the time of sowing and harvesting of lentil while it's yield was recorded at the time of harvesting of lentil.

The guava's growth parameters were increased from the time of lentil seeding to the time of harvest, i.e. plant height 5.20–5.48 m, stem girth 0.360–0.373 m, canopy diameter 5.57–5.60 m, crown length 4.03–4.24 m, shade area length 3.61–3.96 m, and shading area width 3.06–3.22 m (Table 1). During experimental period guava was harvested once, and it's yield was 3885 kg/ha. The yield pattern of guava tree is it produces yield from fourth year of its plantation and increases upto eighth year of plantation and after that it slightly decreases. Growth, yield attributes and yield of lentil are affected considerably due to the shading effect of ten year guava plants for which lentil crop was limited to 0.686 ha after sacrificing some area of one ha guava orchard. Results (Table 2 and 3) indicated that among the treatments, $N_{23.5} + P_{60} + S_{40}$ recorded maximum growth, yield attributes and yield of lentil which was statistically at par with $N_{20} + P_{50} + S_{30}$. Number of green leaves/plant at 60 DAS in lentil

was found significantly higher under $N_{23.5} + P_{60} + S_{40}$. Plant height, number of branches/plant, number of green leaves/plant and dry matter accumulation/plant of lentil increased with increasing doses of nitrogen + phosphorus + sulphur, which might be due to the increased availability of nitrogen, phosphorus and sulphur under acidic rainfed soil at the site of experimentation. Similarly, increased number of root nodules/plant can be due to the increased availability of nutrients and its role in nodules metabolism, phosphorus helps to maintain healthy root nodules growth and rhizobial activity, whereas sulphur availability has been found to be positively linked to more symbiotic nitrogen fixation by accelerating nodule metabolism. Further, increase in grain and stover yield of lentil in $N_{23.5} + P_{60} + S_{40}$ application is the result of the correspondingly better yield attributes in this treatment, viz. number of pods/plant, number of grains/pod, test weight and growth attributes. These findings are in conformity with Singh *et al.* (2018) in Rajmash.

In case of concentrations of urea spray, foliar spray of 2% urea at PF *fb* 2% urea at PI produced significantly higher growth, yield attributes and yield compared to water spray and it was at par with 2% urea spray at PF. These observations might be due to the availability of nitrogen as foliar spray during their active nitrogen-utilization period, which promoted growth and yield of lentil. Also foliar spray of 2% urea at PF stage increased the availability of nitrogen resulting in more nitrogen supply to nodule formation at 60 DAS. The grain yield and stover yield were significantly increased with the increasing concentrations of urea as foliar spray as also reported by Aggarwal *et al.* (2015). Further, more grain and stover yield due to enhanced yield attributes, viz. number of pods/plant, number of grains/pod, test weight and growth attributes. Similar results were also observed

Table 2 Effect of nitrogen + phosphorus + sulphur doses and urea foliar spray on growth attributes of lentil under guava based agri-horti system

Treatment	Plant height (cm)		Number of branches/plant		Number of green leaves/plant	Number of root nodules/plant	Dry matter accumulation/plant (g)	
	At 90 DAS	At harvest	At 90 DAS	At harvest	At 60 DAS	At 60 DAS	At 90 DAS	At harvest
<i>Doses of Nitrogen + Phosphorus + Sulphur (DNPS)</i>								
$N_0 + P_0 + S_0$	20.83c	26.98c	9.78c	11.29c	612.43c	14.57c	16.94c	22.36d
$N_{20} + P_{40} + S_{20}$	24.89b	31.73b	10.76b	12.45b	662.71b	17.22b	17.97b	26.84c
$N_{20} + P_{50} + S_{30}$	25.57ab	33.50a	11.38ab	13.05ab	678.13b	17.96ab	18.78ab	28.49b
$N_{23.5} + P_{60} + S_{40}$	26.35a	34.38a	12.07a	13.59a	729.04a	18.84a	19.59a	30.48a
SEM (\pm)	0.36	0.48	0.25	0.29	13.39	0.32	0.28	0.32
CD (P=0.05)	1.24	1.65	0.87	1.01	46.35	1.09	0.98	1.10
<i>Concentrations of Urea as Foliar Spray (CUFS)</i>								
Water spray at PF	23.74b	30.25b	10.69b	12.24b	654.23b	16.59b	17.92b	26.23b
Urea 2% at PF	24.52a	32.09a	11.01a	12.62a	672.18a	17.25a	18.35a	27.21a
Urea 2% at PF <i>fb</i> 2% at PI	24.97a	32.60a	11.29a	12.93a	685.32a	17.61a	18.70a	27.69a
SEM (\pm)	0.18	0.30	0.10	0.12	5.59	0.18	0.13	0.24
CD (P=0.05)	0.53	0.90	0.30	0.36	16.76	0.53	0.39	0.71
Interaction	NS	NS	NS	NS	NS	NS	NS	NS

Table 3 Effect of nitrogen + phosphorus + sulphur doses and urea foliar spray on yield attributes and yield on lentil (0.6857 ha) and system economics under guava + lentil based agri-horti system

Treatment	No. of pods/ plant	No. of grains/ pod	Test weight (g)	Lentil grain yield (kg/ha GP)	Lentil stover yield (kg/ha GP)	Net return (₹/ha)	Benefit- cost ratio
<i>Doses of Nitrogen + Phosphorus + Sulphur (DNPS)</i>							
N ₀ +P ₀ +S ₀	72.10c	1.34c	20.18c	422.09c	771.03c	83181c	2.54b
N ₂₀ +P ₄₀ +S ₂₀	82.04b	1.77b	23.22b	643.03b	1014.07b	94075b	2.67a
N ₂₀ +P ₅₀ +S ₃₀	86.22ab	1.90ab	23.87ab	708.18ab	1108.78ab	97341ab	2.70a
N _{23.5} +P ₆₀ +S ₄₀	90.58a	2.01a	24.77a	768.36a	1157.69a	100070a	2.71a
SEM (±)	2.43	0.06	0.41	19.70	29.78	1221.96	0.03
CD (P=0.05)	8.42	0.21	1.41	68.17	103.04	4228.69	0.12
<i>Concentrations of Urea as Foliar Spray (CUFS)</i>							
Water spray at PF	79.05b	1.58b	21.85b	594.84b	979.12b	91314b	2.59b
Urea 2% at PF	83.32a	1.79a	23.31a	647.70a	1018.44a	94370a	2.67a
Urea 2% at PF <i>fb</i> 2% at PI	85.84a	1.88a	23.87a	663.70a	1041.12a	95316a	2.70a
SEM (±)	1.03	0.04	0.20	11.78	12.78	700.80	0.02
CD (P=0.05)	3.08	0.12	0.59	35.33	38.31	2101.10	0.06
Interaction	NS	NS	NS	NS	NS	NS	NS

* PF, Pre-flowering stage; PI, Pod initiation stage; GP, Guava plantation. Net return, it include lentil grain yield, lentil stover yield and guava yield. Yield of guava/ha = 3,885 kg; Market price of guava = ₹25/kg.

by Pal *et al.* (2020) and Singh *et al.* (2022).

Combined economics of lentil + guava (Table 3) showed significantly higher net return (₹100070/ha) and benefit-cost ratio (2.71) were observed due to application of N_{23.5}+P₆₀+S₄₀ which was at par with N₂₀+P₅₀+S₃₀ (2.70). However, in case of benefit-cost ratio it was also at par with N₂₀+P₄₀+S₂₀ (2.67). In case of concentrations of urea as foliar spray, the higher net return (₹95316/ha) and benefit-cost ratio (2.70) were noted with foliar spray of 2% urea at PF *fb* by 2% urea at PI which was at par with 2% urea spray at PF. Similar results were also observed by Pal *et al.* (2020) and Singh *et al.* (2022).

SUMMARY

An experiment was conducted at research farm of Rajiv Gandhi South Campus, Barkachha, Mirzapur situated in eastern Uttar Pradesh during winter (*rabi*) season of 2021–22 with the objective to study the response of nitrogen, phosphorous, sulphur doses and urea foliar spray on lentil growth attributes, yield attributes, yield and economics under guava + lentil based agri-horti system. Results revealed that the higher growth, yield attributes, yield, net monetary returns and benefit-cost ratio were recorded under N_{23.5}+P₆₀+S₄₀ which was at par with N₂₀+P₅₀+S₃₀. In case of varied doses of foliar spray of urea, foliar spray of 2% urea at pre-flowering stage *fb* 2% urea at pod initiation stage recorded significantly higher growth, yield, yield attributes and economics which was at par with foliar spray of 2% urea spray at pre-flowering stage. Moreover, between the sowing of the lentils and the harvest, the guava's growth attributes were also increased. Therefore, under rainfed conditions of Vidhyan region of eastern Uttar Pradesh, application of nitrogen, phosphorus and sulphur @20, 50 and 30 kg/ha

as basal application along with foliar application (spray) of 2% urea at pre-flowering stage (45 DAS) to lentil crop was found to be better option for higher profitability under guava plantation.

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