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Response of green manuring, phosphorus and potash on growth, yield attributes and economics of bidi tobacco under middle Gujarat conditions

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Abstract
The present study, titled "Response of green manuring, phosphorus and potash on growth, yield attributes and economics of bidi tobacco under middle Gujarat conditions" was carried out at Bidi Tobacco Research Station, Anand Agricultural University, Anand (Gujarat) during the *kharif-Rabi* season 2021-22. The soil of the experimental unit was loamy sand in texture with low in organic carbon (0.34%) and available nitrogen (173 kg/ha), medium in available phosphorus (36 kg/ha) and high in available potash (301 kg/ha) with pH 7.54 and EC 0.20 dS/m. The research comprised eight treatment combinations and four replications, and it was set up in a split plot design.

The details of treatments are as follows, T_1 **(**Without Green manuring + 0 kg P_2O_5/ha + 0 kg K_2O/ha), T_2 (Without Green manuring + 0 kg P_2O_5/ha + 50 kg K_2O/ha), T_3 (Without Green manuring + 50 kg P_2O_5/ha + 0 kg K_2O/ha), T_4 (Without Green manuring + 50 kg P_2O_5/ha + 50 kg K_2O/ha), T_5 (With Green manuring + 0 kg P_2O_5/ha + 0 kg K_2O/ha), T_6 (With Green manuring + 0 kg P_2O_5/ha + 50 kg K_2O/ha), T_7 (With Green manuring + 50 kg P_2O_5/ha + 0 kg K_2O/ha), T_8 (With Green manuring + 50 kg P_2O_5/ha + 50 kg K_2O/ha). Recommended dose of nitrogen (180 kg/ha) was applied in four equal splits; 1st split as basal through Ammonium Sulphate and remaining three splits through Urea each at 30 days interval after transplanting.

Application of green manuring resulted into significantly higher growth and yield attributes like plant height (19.03, 103.83 and 117.82 cm), leaf length (40.78, 66.41, and 67.96 cm) at 45, 90 DATP and at harvest. Whereas, it failed to exert their significant effect on leaf width. The results of the experiments revealed that growth score (7.49), spangle score (3.58), dry weight per unit leaf area (10.13 mg/cm^2) and cured leaf yield (4712 kg/ha) were also significantly affected due to green manuring.

Application of phosphorus @ 50 kg/ha resulted into significantly higher plant height (19.17, 100.75 and 117.95 cm at 45, 90 DATP and at harvest), leaf length (67.28 cm) at harvest. Whereas, it failed to exert their significant effect on leaf width. Results of the experiments revealed that growth score (7.28), spangle score (3.49), dry weight per unit leaf area (10.09 mg/cm^2) and cured leaf yield (4545 kg/ha) were also significantly affected due to application of phosphorus @ 50 kg/ha. While in case of potash application, it failed to exert its significant effect on plant height, leaf length, leaf width, growth score, spangle score, dry weight per unit leaf area. But significantly higher cured leaf yield (4566 kg/ha) was observed under application of potash @ 50 kg/ha.

Interaction of green manuring with application of phosphorus exerted their significant effect on growth score, spangle score, dry weight per unit leaf area of bidi tobacco. Among all interactions, green manuring with application of phosphorus @ 50 kg/ha resulted in significantly the highest growth score, spangle score and dry weight per unit leaf area.

In case of economics, net realization was higher in green manuring (239755 ₹/ha) as compared to without green manuring (201060 ₹/ha) and BCR was recorded significantly higher (3.89) under green manuring as compared to no green manuring (3.64). economic study also revealed that, net realization was higher in case of application of phosphorous (229795 ₹/ha) and potash (231560 ₹/ha) as compared to no any application of phosphorus (211020 ₹/ha) and potash (209254 ₹/ha) and BCR was also higher under application of phosphorous (3.81) and potash (3.84) as compared to no application of phosphorous (3.72) and potash (3.69).

Keywords: Green manuring, phosphorus, potash, bidi tobacco

Introduction
Tobacco is the most widely grown commercial non-food crop in the world. Tobacco is a self-pollinated, C_3 and short-day plant. Tobacco is an annual growing plant with tap root system. The majority of root system is confined to upper 60-90 cm of the soil. It is an important commercial crop in view of revenue generation, export earnings and employment potential. It is known as golden leaf of India.

In world, main tobacco producing countries are China, Brazil, India, U.S.A and others. India is one of these principal tobacco producing countries in the world. In India, tobacco is grown in area of 0.45 M ha accounting for less than 0.30% of country's arable land, producing 804 M kg of cured leaf (Anon., 2020) [1]. Among various types of tobacco grown in India, bidi tobacco ranks second, accounting for 35% of the total tobacco area and first in production accounting for 33% of total tobacco production in the country. In Gujarat, tobacco is cultivated in around 1.59 lakh ha, the major type being bidi tobacco. The other types of tobacco grown in Gujarat are chewing (Lal and kala chopadia), Hookah (Gadaku) and rustica, which are grown in about 40,000 ha. Total production comes to about 263 M kg with a productivity of 1658 kg/ha.

Middle Gujarat soils are low in organic carbon content. Cultivation of tobacco in the same piece of land year after year without application of any organic manure may lead to depletion of organic carbon. Farm yard manure, compost, vermicompost, green manure, poultry manure etc. are the different sources of manure application. Among these sources, green manuring is most important for tobacco crop. It can be defined as practices of ploughing or turning the un-decomposed green plant tissues in the soil. Green manuring increases the organic matter regime of the soil and there by modifies soil physical, chemical and biological environments and this stimulates the activity of soil micro-organisms. Green manure crops help for returning different plant nutrients to the surface soil layer from the sub-surface soil layer. It improves soil structure, aeration, permeability and infiltration capacity of soil. It reduces soil loss caused by runoff erosion. Sunnhemp is the most outstanding green manure crop. It is well suited to almost all parts of the country, provided that the area receives sufficient rainfall or has an assured irrigation.

Phosphorus is a major element which is essential for plant growth. It involves in energy transfer processes, being constitute of ATP. Potassium is absolutely essential to plant growth and cannot be replaced entirely by any other element. Potassium is an important nutrient for plant meristematic growth and physiological functions, including regulation of water and gas exchange in plants, protein synthesis and activation of various enzyme.

Materials and Methods

In order to achieve the pre-set objectives of the proposed research, a field experiment was carried out during the *kharif-rabi* season of the year 2021-22 on plot no. 10-A at Bidi Tobacco Research Station, Anand Agricultural University, Anand (Gujarat) to study the Response of green manuring, phosphorus and potash on bidi tobacco under middle Gujarat conditions. The soil of the experimental unit was loamy sand in texture (locally called as "*Goradu*" soil) with low in organic carbon (0.34%) and available nitrogen (173 kg/ha), medium in available phosphorus (36 kg/ha) and high in available potash (301 kg/ha) with pH 7.54 and EC 0.20 dS/m. Bidi tobacco variety GABTH-2 (Gujarat Anand Bidi Tobacco Hybrid-2) was selected for experiment. The experiment was arranged in split plot design with four replication, consisting with eight treatment combinations; T_1 **(**Without Green manuring + 0 kg P_2O_5/ha + 0 kg K_2O/ha), T_2 (Without Green manuring + 0 kg P_2O_5/ha + 50 kg K_2O/ha), T_3 (Without Green manuring + 50 kg P_2O_5/ha + 0 kg K_2O/ha), T_4 (Without Green manuring + 50 kg P_2O_5/ha + 50 kg K_2O/ha), T_5 (With Green manuring + 0 kg P_2O_5/ha + 0 kg K_2O/ha), T_6 (With Green manuring + 0 kg P_2O_5/ha + 50 kg K_2O/ha), T_7 (With Green manuring + 50 kg P_2O_5/ha + 0 kg K_2O/ha), T_8 (With Green manuring + 50 kg P_2O_5/ha + 50 kg K_2O/ha). Recommended dose of nitrogen (180 kg/ha) was applied in four equal splits; 1st split as basal through Ammonium Sulphate and remaining three splits through Urea each at 30 days interval after transplanting. Phosphorus and potash were applied as basal before transplanting.

The collected data for various parameters were statistically analysed using Fishers analysis of variance (ANNOVA) technique and the treatments were compared at 5% level of significance. All the observations of growth, yield attributes and quality parameters were taken as per standard method.

Results and Discussion

Effect on growth and yield attributes

An examination of data given in Table 1 revealed that The results indicated that plant height was significantly affected due to green manuring. Plant height was significantly higher 19.03, 103.83, 117.82 cm at 45, 90 DATP and at harvest, respectively under green manuring as compared to without green manuring. That plant height was affected significantly due to phosphorus application. Application of phosphorus at 50 kg/ha gave higher plant height at 45, 90 DATP and at harvest. Whereas, application of various levels of potash did not affect plant height at 45, 90 DATP and at harvest. Periodical plant height recorded at 45, 90 DATP and at harvest was not significantly influenced due to interaction between green manuring, phosphorus and potash levels.

Leaf length was significantly higher at 45, 90 DATP and at harvest due to green manuring with sunnhemp. These findings are in line of those reported by Desai (2007) [2] and Gediya *et al*. (2020) [3]. Leaf length at 45 and 90 DATP was not significantly altered due to phosphorus application. Whereas, significantly higher leaf length (67.28 cm) at harvest was observed under application of phosphorus @ 50 kg/ha as compared to no phosphorus application at harvest. Leaf length at 45, 90 DATP and at harvest was not significantly influenced due to interaction between green manuring, phosphorus and potash levels.

Green manuring did not exert their significant influence on leaf width at 45, 90 DATP and at harvest. It was not significantly differed due to different levels of phosphorus and potash. It was also not changed due to interaction effect of green manuring, phosphorus and potash.

Growth score of bidi tobacco was significantly influenced due to green manuring (7.49) as compared to without green manuring (6.64). Promotion of physiological activities of plant which might ultimately increase growth attributes as well as growth score. It was improved due to phosphorus application (7.28) as compared to no phosphorus application (6.85). Whereas, potash application failed to exert its significant effect on growth score. In case of interaction effect, G_1P_1 (green manuring along with application of phosphorus @50 kg/ha) gave significantly the highest growth score 7.76 followed by 7.21 (G_1P_0), 6.79 (G_0P_1) and significantly the lowest growth score 6.49 was recorded under (G_0P_0) treatment combination of without green manuring and no phosphorus application.

Spangle score of bidi tobacco was significantly influenced by green manuring (3.58) as compared to no green manuring (3.25). It might be due to promotion of physiological and enzymatic activities of plant which might ultimately increase the growth attributes as well as spangle score. Results revealed that spangle score was improved due to phosphorus

application (3.49) as compared to no phosphorus application (3.34). These findings are supported as per the results obtained by Patel (1990) whereas, potash application failed to exert its significant effect on spangle score. In case of interaction effect, G_1P_1 (green manuring along with application of phosphorus @50 kg/ha) gave significantly the highest spangle score 3.73 followed by 3.43 (G_1P_0), 3.26 (G_0P_0) and significantly the lowest growth score 3.25 was recorded under (G_0P_1) treatment combination of without green manuring and phosphorus application at 50 kg/ha.

Effect of green manuring on dry weight per unit area of leaf (mg/cm^2) was found significant. Dry weight per unit area of leaf was significantly higher (10.13 mg/cm^2) with green manuring as compared to no green manuring (9.51 mg/cm^2). significantly higher dry weight per unit leaf area (10.09 mg/cm^2) was observed under application of phosphorus @ 50 kg/ha as compared to no phosphorus application (9.55). Whereas, potash did not manifest any significant effect on dry weight per unit area of leaf (mg/cm^2) at harvest. In case of interaction effect, G_1P_1 (green manuring along with application of phosphorus @ 50 kg/ha) gave significantly the highest dry weight per unit leaf area 10.56 followed by 9.70 (G_1P_0), 9.62 (G_0P_1) and significantly the lowest growth score 9.40 was recorded under (G_0P_0) treatment combination of without green manuring and no phosphorus application.

Significantly higher cured leaf yield (4712 kg/ha) was observed under green manuring as compared to no green manuring (4043 kg/ha) treatment. It might be due to green manuring improves soil physical properties, also increases organic matter and available nutrients. That ultimately increases plant growth and cured leaf yield. Similar results were founded by Bilalis *et al.* (2009) [4] and Travlos *et al.* (2014) [5]. Application of phosphorus at 50 kg/ha gave significantly higher cured leaf yield (4545 kg/ha) as compared to no phosphorus application (4209 kg/ha). Similar trend was observed by Landrau *et al.* (1959) [6] and Gopalachari, *et al.* (1972) [7]. Similarly, an application of potash at the rate of 50 kg/ha also gave significantly higher cured leaf yield (4566 kg/ha) as compared to no potash application (4188 kg/ha) these findings are in line of those reported by Kumaresan and Krishnamurthy (2013) [8] and Gholizadeh (2012) [9]. Increased in cured leaf yield might be due to application of higher dose of phosphorus and potash which, might help the vegetative growth of crop and ultimately it increased the cured leaf yield of bidi tobacco. Whereas, interaction between green manuring, phosphorus and potash was failed to reach the level of significance on cured leaf yield of bidi tobacco.

Effect on Economics

Results revealed that highest net return (239755 ₹/ha) was secured due to green manuring as compared to no green manuring (201060 ₹/ha). In case of BCR, significantly higher value (3.89) was recorded under green manuring as compared to no green manuring (3.64).

Higher net return (229795 ₹/ha) was obtained with application of phosphorous @ 50 kg/ha as compared to no phosphorus application (211020 ₹/ha). Where as in case of potash application, higher net return (231560 ₹/ha) was obtained with application of potash @ 50 kg/ha as compared to no potash application (209254 ₹/ha). In case of BCR, significantly higher value (3.81 and 3.84) was recorded under application of phosphorus and potash respectively @ 50 kg/ha as compared to no application of phosphorous (3.72) and potash (3.69).

Table 1: Growth and yield attributes of bidi tobacco as influenced by green manuring, phosphorus and potash application

Treatments		Plant height (cm)			Leaf length (cm)			Leaf width (cm)			Growth Score (0-10)	Spangle Score (0-5)	Dry weight per unit leaf area (mg/cm^2)	Cured leaf yield (kg/ha)
		45 DATP	90 DATP	At harvest	45 DATP	90 DATP	At harvest	45 DATP	90 DATP	At harvest				
Main plot (Green manuring)														
G_0: Without green manuring		16.10	95.01	110.42	37.43	62.34	62.93	19.54	27.17	28.86	6.64	3.25	9.51	4043
G_1: With green manuring		19.03	103.83	117.82	40.78	66.41	67.96	20.71	28.24	30.62	7.49	3.58	10.13	4712
S.Em±		0.32	1.73	1.46	0.70	0.87	0.85	0.37	0.50	0.529	0.10	0.05	0.13	147.3
CD (0.05%)		1.42	7.80	6.57	3.15	3.90	3.81	NS	NS	NS	0.46	0.24	0.57	663
CV (%)		7.21	6.98	5.12	7.16	5.38	5.18	7.33	7.16	7.12	5.74	6.19	5.14	13.46
Sub plot (Phosphorus and potash combination)														
P levels (kg/ha)	P_0: 0	15.96	98.09	110.29	38.17	63.33	63.61	19.82	27.44	29.68	6.85	3.34	9.55	4209
	P_1: 50	19.17	100.75	117.95	40.04	65.42	67.28	20.44	27.98	29.80	7.28	3.49	10.09	4545
S.Em±		0.24	0.83	1.20	0.65	0.76	0.75	0.34	0.45	0.465	0.04	0.05	0.10	111.4
CD (0.05%)		0.70	2.47	3.57	NS	NS	2.22	NS	NS	NS	0.12	0.14	0.29	331
K level (kg/ha)	K_0: 0	17.23	98.40	112.42	38.62	63.71	64.40	19.75	27.59	7.01	7.01	3.36	9.71	4188
	K_1: 50	17.90	100.44	115.82	39.59	65.04	66.49	20.51	27.83	30.42	7.12	3.47	9.93	4566
S.Em±		0.24	0.83	1.20	0.65	0.76	0.75	0.34	0.45	0.465	0.04	0.05	0.10	111.4
CD (0.05%)		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	331
Interaction Effect														
G X P		NS	NS	NS	NS	NS	NS	NS	NS	NS	Sig	Sig	Sig	NS
G X K		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
P X K		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
G X P X K		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)		5.36	3.33	4.21	6.66	4.71	4.57	6.71	6.51	6.25	2.28	5.68	3.93	10.18

Table 2: Interaction effect of green manure and phosphorus on growth score and spangle score of bidi tobacco

Green manuring	Phosphorus			
	Growth score		Spangle score	
	P_0	P_1	P_0	P_1
G_0	6.49	6.79	3.26	3.25
G_1	7.21	7.76	3.43	3.73
S.Em ±	0.06		0.07	
CD (0.05%)	0.17		0.20	
CV (%)	2.28		5.68	

Table 3: Interaction effect of green manure and phosphorus on dry weight per unit leaf area bidi tobacco

Green manuring	Phosphorus	
	Dry weight per unit leaf area (mg/cm^2)	
	P_0	P_1
G_0	9.40	9.62
G_1	9.70	10.56
S.Em ±	0.14	
CD (0.05%)	0.41	
C. V. (%)	3.93	

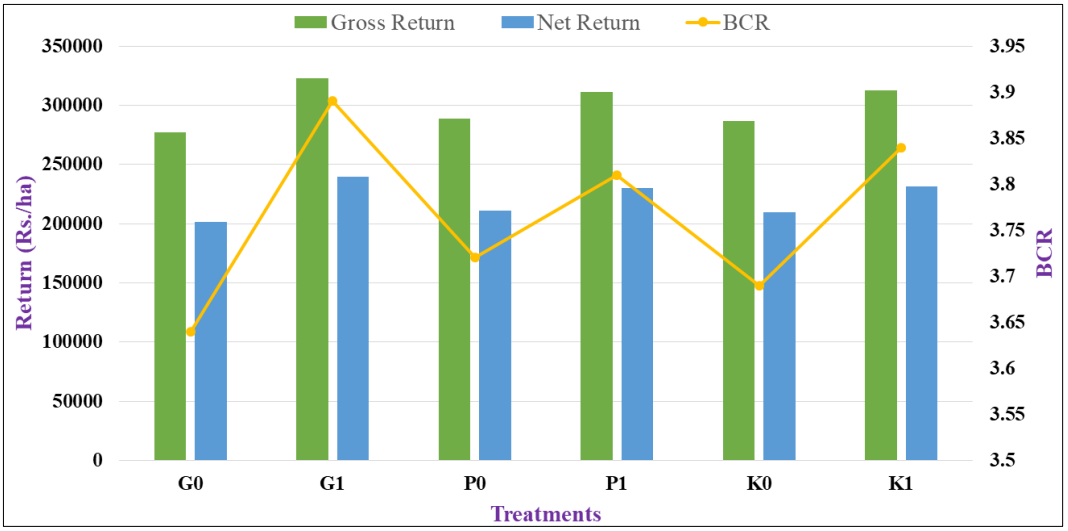

Fig 1: Economy as influenced by green manuring, phosphorus and potash application

Conclusion

In light of results obtained from the present investigation, it could be concluded that for securing higher cured leaf yield and net return, bidi tobacco (cv. GABTH 2) should be fertilized with recommended dose of fertilizer (180-0-0: N-P-K kg/ha) in addition with green manuring (sunnhemp). It could also be concluded that application of 50 kg P_2O_5 as well as 50 kg K_2O/ha resulted into higher cured leaf yield and net return.

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