Plant Archives Vol. 20 Supplement 1, 2020 pp. 2539-2542 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

GROWTH, YIELD AND ECONOMICS OF FODDER CROPS TO VARYING NPK LEVELS IN A GUAVA BASED HORTI-PASTORAL SYSTEM

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Abstract

The growth, yield and economics of rainfed fodder crops (pearl millet, sorghum and sudan grass) as influenced by with four NPK levels *viz.* control, 75%, 100% and 125% recommended dose of fertilizers (RDF) was evaluated in a horti-pastoral system. Experiment was laid out in a randomized complete block design replicated thrice. Among the test crops, pearl millet gave significantly higher values of plant height, number of nodes plant^{-1}, green leaves plant^{-1}, leaf area index, shoot weight plant^{-1} (fresh and dry) and fodder yield. Application of 125 % RDF also resulted significantly higher values of above parameters than rest of the NPK levels except 100% RDF. Fodder pearl millet accrued highest gross returns, net returns and B: C ratio with use of 125% RDF.

Key words: Economics, Fodder crop, Horti-pastoral system, NPK levels and Yield.

Introduction

Productivity of rainfed crops is often adversely affected due to drought. Reductions in yields are more pronounced under rainfed conditions than the irrigated ones. The establishment of fruit orchards is a common practice in the Vindhyan region. Guava is an important fruit crop popularly grown by the native farmers. Adoption of an agroforestry system may be a potential alternative where woody perennials combine with arable crop on the same land management unit. Agro-forestry systems advocate higher total biomass production, profit and sustainability with efficient use of resources than the crop component alone. The interspaces available between orchards may be successfully utilized to grow fodder sorghum, pearl millet and grasses under wide range of environmental conditions (Orwa *et al.,* 2009). These fodder crops produces optimum yield levels under water deficit and high temperature stress conditions (Smith and Frederiksen, 2000). Quick growing rainfed fodder crops may produce high dry matter in short duration with better quality. Sorghum has remarkable ability to recover from short term drought (Martin J.H., 1930) due to lower transpiration ratio and less water depletion from the soil (Merrill *et al.,* 2007). Judicious use of fertilizer increases forage yield and improves quality especially protein contents (Ayub *et al.,* 2007). Nitrogen (N) has special significance in dynamic vegetative growth, imparts green color, improve biomass and essential for protein production. Phosphorus (P) plays a vital role in physiology and biochemistry of plants since involved as a component of genetic material (nucleic acids), as energy currency (ATP) of plants, fixation of CO_2, sugar metabolism and storage and transfer of energy (Demkin and Ageev 1990) and also stimulates root growth and drought tolerance in plant. Potassium (K) is involved in the plant developmental process, activates >60 enzymes commonly considered as the quality nutrient. The management of primary nutrients (N, P, K) is of paramount importance for sustainable crop production under rainfed conditions. The present study was conducted to evaluate the performance of fodder crops under varied NPK levels in a guava based horti-pastoral system.

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Materials and Methods

A field experiment was conducted at Agricultural Research Farm, Rajiv Gandhi South Campus Barkachha in the Vindhyan region of Mirzapur district located at 25º 10'N latitude and 82º37' E longitudes and altitude of 147 meters above sea level. This region falls under agro-

Table 1: Effect of fodder crops and varying NPK levels on growth parameter at harvest grown under guava based horti pastoral system.

Treatments	Plant population (m^{-2})		Plant height (cm)	Number of green leaves $plant^{-1}$	Number of nodes $plant^{-1}$	Leaf area index	Shoot weight (gram)	
Rainfed crops	**Initial**	**Final**					**Fresh**	**Dry**
C_1: Bajra	14.67	13.88	166.25	13.64	8.42	13.43	156.60	42.06
C_2: Jowar	14.33	13.51	165.81	12.78	7.73	12.11	146.65	41.27
C_3:Sudan grass	14.25	13.00	150.58	12.69	7.71	11.43	145.14	39.04
SEm±	0.19	0.13	3.74	0.26	0.21	0.32	0.32	0.06
CD (*P*=0.05)	NS	NS	10.96	0.77	0.61	0.93	0.94	0.18
NPK Levels (kg ha^{-1})								
N_0: Control	14.00	13.00	138.95	9.72	6.29	10.03	122.48	37.32
N_1:75% RDF	14.33	13.44	154.31	12.93	7.84	12.12	146.10	40.67
N_2:100% RDF	14.56	13.51	172.85	14.40	8.69	13.52	164.38	42.58
N_3:125% RDF	14.78	13.89	177.41	15.08	8.99	13.62	164.90	42.59
SEm±	0.22	0.15	4.31	0.30	0.24	0.37	1.08	0.07
CD (*P*=0.05)	0.64	0.45	12.65	0.89	0.70	1.08	4.88	0.20
Interaction	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Effect of fodder crops and varying NPK levels on yield grown under guava based horti pastoral system.

Treatments	Yield (q ha^{-1})	
Rain-fed crops	**Green fodder**	**Dry fodder**
C_1:Bajra	215.96	56.57
C_2:Jowar	196.35	54.42
C_3:Sudan grass	189.91	50.92
SEm±	2.54	0.44
CD (*P*=0.05)	7.45	1.29
NPK Levels (kg ha^{-1})		
N_0: Control	159.75	48.07
N_1:75% RDF	193.28	53.85
N_2:100% RDF	215.30	54.83
N_3:125% RDF	234.63	59.14
SEm±	2.93	0.51
CD (*P*=0.05)	8.60	1.49
Interaction	NS	NS

climatic zone III (eastern semi-arid plain area). The experimental soil was sandy loam in texture, acidic in reaction (pH 5.89) low in nitrogen availability (225.63 kg ha^{-1}) with moderate phosphorus (20.97 kg ha^{-1}) and potassium (243.38 kg ha^{-1}). The experiment was laid out during rainy season of 2018 in a randomized complete block design replicated thrice. Test fodder crops (sorghum, pearl millet and sudan grass) with four NPK levels (N_0 = control, N_1 = 75% RDF, N_2 = 100% RDF, N_3 = 125% RDF) were sown in an eleven year old guava planted at a spacing of 7 × 7 meters. Test crops were sown by leaving a space of 0.5 meter from tree base made each side. The RDF (N, P, K) used in the experiment was 80, 40, 20 kg ha^{-1}. Recommended seed rate adopted to raise fodder test crops *i.e.* pearl millet @ 10, sorghum @ 40 and sudan grass @ 12 kg ha^{-1}. Fodder crops were manually sown in the interspaces of guava at a row distance of 30 cm.

Growth attributes and yield

The observations on growth attributes (plant population, plant height, green leaves $plant^{-1}$, nodes $plant^{-1}$, fresh and dry shoot weight $plant^{-1}$ and leaf area index) were recorded from five randomly selected plants from each plot. Fodder was harvested once close to ground at 60 days after sowing. Guava fruit yield was recorded from three trees randomly selected from each replication, averaged and expressed in kg ha^{-1}.

Economics

Economics of the treatments were separately calculated by taking into account the prevailing input and output prices. Cost of cultivation was calculated by taking into account all the expenses incurred during experimentation. Gross return was calculated by multiplying the total green fodder yield $hectare^{-1}$ with their current market price. Net return and B: C ratio was calculated with the help of the following formula:

Net return (₹ ha^{-1}) = Gross return (₹ ha^{-1}) – Cost of cultivation (₹ ha^{-1})

$$\text{Benefit : cost ratio} = \frac{Net\ return\ (₹\ ha^{-1})}{Cost\ of\ cultivation\ (₹\ ha^{-1})}$$

Result and Discussion

Growth parameters

Fodder crops exerted significant variations in all growth attributes *viz.* plant height, green leaves $plant^{-1}$, nodes $plant^{-1}$, fresh and dry shoot weight $plant^{-1}$ and leaf area index except plant population (Table 1). Pearl millet exhibited significantly superior growth attributes over rest of the crops however, its plant height found at par with sorghum. Pearl millet grows vigorously and become taller than other crops. Greater plant height gained by pearl millet caused significantly greater value of other growth parameters than sorghum and sudan grass. Similar results

Table 3: Effect of fodder crops and varying NPK levels on economics under guava based horti-pastoral system at harvest.

Treatment	Total gross return(₹ ha^{-1})	Net return (₹ ha^{-1})	Benefit: cost Ratio
C_1N_0	62600.00	43328.70	2.25
C_1N_1	76320.00	54639.80	2.52
C_1N_2	85062.00	62501.70	2.77
C_1N_3	91634.00	68225.70	2.91
C_2N_0	62045.00	41473.70	2.01
C_2N_1	69469.00	46488.80	2.02
C_2N_2	77606.00	53745.70	2.25
C_2N_3	82972.00	58263.70	2.36
C_3N_0	61483.00	41501.70	2.08
C_3N_1	70514.00	48123.80	2.15
C_3N_2	73454.00	50183.70	2.16
C_3N_3	78910.00	54791.70	2.17

Note: Green fodder price- Rs 3 kg^{-1}

have been reported by Thumar *et al.,* (2016). Out of different NPK levels, 125% RDF gave maximum value of plant height, number of green leaves plant^{-1}, number of nodes plant^{-1} and LAI which were significantly superior over 75% RDF and control. However, 100% RDF was found at par with 125% RDF (Table 1). Higher plant population was recorded with 125% RDF found at par with 100% RDF and 75% RDF (Table 1). Probably, increasing the quantity of NPK provided vigorous growth. Higher photosynthetic surface area intercepts more solar energy that is sufficient for higher photosynthetic activity and produced more photosynthates in plants. These results are supported by the findings of Obeng *et al*., (2012). Yadav *et al.,* 2017 and Vaishy *et al.*, 2019 also reported that higher dose of nitrogen produces greater value of plant height, green leaves plant^{-1}, number of nodes plant^{-1} and leaf area index (LAI) of fodder crops.

Yield and Economics

Fodder yield

Yield of crop is the function of all the growth parameters *viz.* plant height, number of tillers hill^{-1}, number of green leaves hill^{-1}, leaf area index, fresh and dry weight of plant. Dry and fresh fodder yields significantly altered due to fodder crops and NPK levels (Table 2). The pearl millet proved significantly superior over other crops and produced higher green and dry fodder yields. Similar results were reported by Kaushik *et al.,* (2015). Application of 125% RDF recorded significantly highest green and dry fodder yields. Higher fodder yields obtained with higher NPK level was actually due to the accelerated formation of nucleotides and co-enzymes, protein synthesis, and photosynthetic activity which created favourable effect on growth and development of plants. This view also confirms the observations made by Bhuva *et al.,* (2018) and Rana *et al.,* (2013). Senthilkumar *et al.,* 2018 and Togas *et al.,* 2017 also reported that application of higher dose of fertilizer significantly increases the stover yield of perl millet. None of the interactions were significant.

Economics

The practical utility of any treatment can be judged by gross returns, net returns and B: C ratio. Maximum gross return (91634.00₹ ha^{-1}) and net return (68225.70 ha^{-1}) was obtained when pearl millet received 125% RDF (Table 3). This treatment combination proved most effective in terms of the economics since produced relatively more fodder yield. The highest B: C ratio (2.91) was recorded with pearl millet + 125% RDF while minimum with sorghum + control (Table 3). Similar observations also reported by Reddy *et al.,* (2016).

Conclusions

Results indicate that to achieve higher productivity and net return under rainfed condition, fodder pearl millet suitable with application of NPK @ 100, 50, 25 kg ha^{-1} in guava based horti-pastoral system. Horti-pastoral system also distributes the risk between perennial (guava) and annual crops components. Farm income stabilization, nutritional security and employment generation are possible by harmonizing fruit plants with fodder crops.

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