

Effect of Agrihorticultural Systems and Varying NPK Levels on Growth and Yield of Pearlmillet (*Pennisetum glaucum*) in Vindhyan Region

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Abstract A field experiment was conducted during rainy season of 2011 to assess the effect of agrihorticultural systems and varying NPK levels on growth and yield of pearl millet in Vindhyan region. Yield attributes were maximum under open canopy at par with guava based system but both proved significant superiority over custard apple based system. Open canopy registered 18.90% and 10.91% higher grain yield while 12.67% and 7.56% more stover yield compared to custard apple and guava based systems, respectively. Increase in NPK levels up to 100% RDF (80 kg N, 40 kg P₂O₅ and 40 kg K₂O ha⁻¹) resulted significantly enhanced number of tillers plant⁻¹, dry matter accumulation plant⁻¹, number of grains ear⁻¹, grain and stover yields. However, number of ears plant⁻¹ (1.61) and 1000 grain weight (10.18) significantly increased up to 125% RDF. Additional income by fruit yield (custard apple and guava) reversed the trend and the highest net return (Rs 46510.25 ha⁻¹) and B : C ratio (2.20) recorded under custard apple based agrihorti system with 100% NPK application. Study reveals that custard apple-pearl millet based agrihorticultural system applied with rec-

ommended dose of fertilizer NPK (80-40-40 kg ha⁻¹) found most suitable for achieving higher net returns in Vindhyan region.

Keywords Agrihorticultural systems, NPK levels, Pearlmillet.

Introduction

Pearlmillet is an important crop cultivated in an area of 9.61 million hectares in India with annual production of 10.37 million tonnes and average productivity of 1079 kg ha⁻¹ [1]. The economic survival of the farming community of district Mirzapur (Vindhyan region) depends on the cultivation of short duration *khari* crops under rainfed condition. Pearlmillet is popularly grown as a rainfed crop in the region due to its drought resistance and better adaptation even on marginal soils [2]. Fruit trees like guava and custard apple have been traditionally grown and found promising under agro climate conditions of district Mirzapur. Fruit trees if suitably integrated under agrihorticultural system may add significantly to overall agricultural production including conservation of soil and water with stability in production and income [3]. Agrihorticultural systems play an important role especially in semi-arid regions where production of annual crops is not only low but also at high risk because of its dependence to rainfall. Interspaces available during the initial phase of an orchard establishment and development may be a profitable prepo-

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sition if utilized successfully. Short duration crops like pearl millet may be intercropped to make the best use of resources in an agrihorticultural system. The techniques applied to the crop viz. tillage, interculture, weed control also benefits the trees in agroforestry system [4].

Balanced and optimum use of nitrogen, phosphorus and potassium plays key role in increasing the yield of cereals. Though, the yield potential of existing pearl millet varieties is high, but has not been fully exploited due to lack of balanced fertilization. The optimum dose of primary nutrients (NPK) were determined long back but thereafter, the fertility status and crop varieties have undergone a considerable change, so there is a need to give a fresh look to nutrient requirement (NPK) of rainfed pearl millet under agrihorticultural systems [5]. It is hypothesized that complementary interaction between fruit trees and pearl millet may be advantageous than sole crop (open canopy) for efficient land use and better economic return. Keeping these facts into consideration the objective of study was to find out suitable agrihorticultural system, optimum dose of NPK and their effect on growth and yield of pearl millet in Vindhyan region.

Materials and Methods

A field experiment was carried out during *kharif*, 2011 at the Agronomy Farm, Rajiv Gandhi South Campus, Barkachha, Mirzapur (U.P.) to assess the effect of agrihorticultural systems and varying NPK levels on growth and yield of pearl millet (*Pennisetum glaucum*) in Vindhyan region. The experimental site is located at 25° N latitude 85° E longitudes and at an altitude varying from 168 to 365 meters above mean sea level. The soil samples collected from experimental site were analyzed for mechanical and physico-chemical properties. The soil of experimental field was sandy loam in texture, slightly acidic in reaction with pH 5.6, electrical conductivity 0.30 dSm⁻¹, low in available nitrogen 183.67 kg ha⁻¹ and phosphorus 10.55 kg ha⁻¹ and medium in available potassium 125.8 kg ha⁻¹. The experiment was conducted in split plot design with three main plot treatments [custard apple (S₁), guava (S₂) and open canopy (S₃)] and four lev-

els of NPK (50% RDF, 75% RDF, 100% RDF and 125% RDF) as sub plot treatments replicated thrice. Experiment was laid out in five year old custard apple (*Annona squamosa* L., variety Mammoth) and guava (*Psidium guajava* L., variety L-49) orchard planted during *kharif* 2006-2007 at a spacing of 5m × 5m and 7m × 7m, respectively. Pearl millet variety Koveri Super Boss was sown as an intercrop at 45 × 10 cm in north-south direction leaving a distance of 0.5 meter from fruit tree adopting a seed rate of 8 kg ha⁻¹ with each agrihorti system (custard apple and guava) and an open canopy system. Recommended dose of fertilizers (RDF) used was N₂-P₂O₅-K₂O (80-40-40 kg ha⁻¹). The N, P and K were supplied through urea, diammonium phosphate and muriate of potash, respectively. Variable rates of NPK were applied as per treatments. Half of the recommended dose of nitrogen and full of phosphorus and potassium was applied as basal application and remaining half nitrogen was top dressed one month after sowing. To make the experiment homogenous, the gross and net plot size was laid out in experiment as per interspaces available with custard apple and guava and finally the values expressed in per hectare basis. The rainfall received during the crop season was 974 mm. Standard agronomic practices were followed for raising the experimental crop. The cost of cultivation was worked out by taking into consideration all the expenses incurred. Gross return was worked out by multiplying grain and straw yield of pearl millet along with the fruit yield of custard apple and guava with their prevailing market prices. Total fruit yield of custard apple and guava recorded from the experimental area and represented on per hectare basis. Net return (Rs ha⁻¹) and benefit : cost ratio was calculated with the help of the following formula:

Net return (Rs ha⁻¹) = Gross return (Rs ha⁻¹) - Cost of cultivation (Rs ha⁻¹)

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

Data recorded were analyzed adopting standard method of analysis of variance as suggested by Gomez and Gomez [6].

Results and Discussion

Effect of fruit tree species on pearl millet

Growth parameters

Data revealed that the open canopy recorded maximum dry matter accumulation plant^{-1} (132.53 g) statistically at par with guava based agrihorticultural system however, both the systems registered significantly higher dry matter accumulation than custard apple based agrihorticultural system. Number of tillers plant^{-1} at harvest could not differ significantly due to different agrihorticultural systems. This could be ascribed to lack of competition due to absence of tree component, better care and maintenance of crop under open canopy which resulted better opportunity for crop growth. Better performance of crop in association with guava also indicates minimum competition between crop and the tree component. These results are in conformity with those of Malik and Sharma [7].

Yield attributes

Number of ears plant^{-1} and 1000-grain weight significantly influenced due to various fruit tree species however, response was non-significant in respect of number of grains ear^{-1} . Open canopy recorded significantly highest number of ears plant^{-1} (1.61) over custard apple based agrihorticultural system only and observed at par with the guava based agrihorticultural system. Open canopy recorded maximum 1000-grain weight (9.27) noted at par with guava based system but both produced significantly heavier grains over custard apple based agrihorticultural system. Pearl millet grown under open canopy performed better in absence of any competition with the fruit tree component. This might be due to better access of light, nutrients and space which resulted more growth, higher photosynthate production and ultimately better yield attributes. Guava fruit trees facilitated reduced canopy competition which ultimately helped in superior yield attributes by pearl millet than in custard apple based system. Yield attributes of pearl millet recorded minimum with custard apple based system which may be attributed due to their competitive in-

teraction because of increased shading effect of custard apple trees [8].

Grain yield (kg ha^{-1}) and stover yield (kg ha^{-1})

Grain and stover yield recorded in the order of open canopy > guava based agrihorticultural system > custard apple based agrihorticultural system. Open canopy registered 18.90% and 10.91% higher grain yield than custard apple and guava based agrihorticultural system respectively. Guava based system recorded 9.96% higher grain yield over custard apple based agrihorticultural system. Yield is the cumulative result of growth characters. Minimum grain and stover yield recorded under custard apple based agrihorticultural system may be due to the increased competition between crop and fruit tree component for both above and below the ground for space, sunlight, nutrients and moisture and the findings are in accordance with earlier [9, 10].

Effect of NPK levels on pearl millet

Growth parameters

Maximum number of tillers plant^{-1} and dry matter accumulation plant^{-1} observed under highest NPK level of 125% RDF through significant response was noted with increase in NPK level up to 100% RDF. The growth characters found minimum under lowest NPK level (50% RDF) due to insufficient supply of nutrients to the crop and the findings confirm the earlier results [11, 12].

Yield attributes

Number of ears plant^{-1} increased significantly with each increment in NPK level up to 125% RDF. Maximum number of grains ear^{-1} and 1000-grain weight recorded with application of 125% RDF noted at par with 100% RDF however, both registered their significant superiority over its lower NPK levels (Table 1). Overall improvement in vigor and crop growth due

Table 1. Growth, yield attributes and yields of pearl millet at harvest as influenced by different fruit tree species and NPK levels.

Treatments	No. of tillers plant ⁻¹	Dry-matter accumulation (g) plant ⁻¹	No. of ears plant ⁻¹	No. of grains ear ⁻¹	1000-grain weight (g)	Yield (kg ha ⁻¹)	
						Grain	Stover
Fruit tree species							
Custard apple	2.93	126.73	1.23	1347	8.23	1940	4423
Guava	3.03	131.73	1.38	1377	9.08	2131	4682
Open canopy	3.07	132.53	1.61	1386	9.27	2392	5065
SEm±	0.08	0.92	0.07	16.00	0.16	22	32
CD at 5%	NS	3.60	0.27	NS	0.64	89	126
NPK levels							
50% RDF	2.09	111.31	1.16	1280	7.08	1879	4464
75% RDF	3.00	121.27	1.33	1364	8.64	2084	4721
100% RDF	3.44	142.92	1.53	1402	9.54	2296	4817
125% RDF	3.51	145.87	1.61	1418	10.18	2358	4903
SEm±	0.08	1.04	0.03	12	0.18	37	31
CD at 5%	0.24	3.08	0.07	36	0.62	111	92

to adequate NPK supply during critical plant stages is important in promoting higher assimilation of food and its subsequent partitioning to sink. Thus, NPK fertilization increased yield attributes and stimulated grain setting of pearl millet. Minimum yield attributes recorded with application of 50% RDF (NPK) due to inadequate nutrient supply resulted poor growth and yield attributes as also well reported earlier [9, 10].

Grain yield (kg ha⁻¹) and stover yield (kg ha⁻¹)

An examination of the data revealed that increase in NPK level significantly enhanced grain and stover yield upto 100% RDF further increase in NPK level (125% RDF) though increased the value but could not reach to the level of significance. Maximum and minimum grain and stover yield obtained with 125% RDF (2,358 and 4903 kg ha⁻¹) and 50% RDF (1,879 and 4,464 kg ha⁻¹), respectively. These results are in conformity with earlier reports [5, 13–16].

Economics

Economics of different treatments revealed that gross

return increased with increase in the NPK levels upto the maximum dose of 125% RDF in custard apple and guava based systems while a considerable decrease was recorded with open canopy when NPK levels rose from 100% RDF to 125% RDF. However, net return and B : C ratio increased with increase in the NPK levels up to 100% RDF in all the agrihorticultural systems further increase (125% RDF) lowered the net return and B : C ratio than 100% RDF in all the systems under study (Table 2). Among various treatment combinations, custard apple based agrihorticultural system with 125% RDF resulted maximum gross return (Rs 68,059 ha⁻¹). This may be due to added expenditure incurred on fruit harvesting and greater quantity of fertilizer required. Highest net return and B : C ratio (Rs 46,510.25 ha⁻¹ and 2.20) recorded under custard apple with 100% RDF application. Open canopy with 50% RDF recorded minimum gross and net returns (Rs 39,451 ha⁻¹ and Rs 21,658.65 ha⁻¹) while open canopy with 125% RDF gave minimum B : C ratio (1.18). Grain and stover yields of pearl millet recorded in order of open canopy > guava based system > custard apple based system. However, addition of income from fruit yield reversed this trend and the guava and custard apple based agrihorticultural sys-

Table 2. Effect of different fruit tree species and NPK levels on economics. *Fruit yield : Custard apple = 1001.60 kg ha⁻¹, Guava = 1150.23 kg ha⁻¹, Sale price : Custard apple @ Rs 28 kg⁻¹ and guava @ Rs 20 kg⁻¹.

Treatments combinations	Gross return (Rs ha ⁻¹)	Net return (Rs ha ⁻¹)	B:C ratio
Custard apple+ 50% RDF	59613	40210.65	2.07
Custard apple+ 75% RDF	63052	42877.85	2.12
Custard apple+ 100% RDF	67611	46510.25	2.20
Custard apple+ 125% RDF	68059	45652.65	2.03
Guava+50% RDF	56996	37593.65	1.93
Guava + 75% RDF	61880	41713.85	2.06
Guava+100% RDF	65253	44152.25	2.09
Guava+125% RDF	66380	43943.65	1.95
Open canopy+ 50% RDF	39451	21658.65	1.21
Open canopy+ 75% RDF	43611	25046.85	1.34
Open canopy+ 100% RDF	47155	27664.25	1.41
Open canopy+ 125% RDF	45596	24769.65	1.18

tems found more remunerative than open canopy. This might be due to extra yield of fruits which added profitability of agrihorticultural system and these findings are in accordance with Yadav et al. [17].

Conclusion

Custard apple based agrihorticultural system was found most suitable for achieving higher net returns in Vindhyan region. Optimum fertilizer dose for *kharif* pearl millet variety Koveri Super Boss is NPK 80–40–40 kg ha⁻¹ for custard apple based agrihorticultural system.

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