Effect Of Different Fertilizer Levels on Growth and Yield of Linseed (*Linum usitatissimum*) under Guava (*Psidium guajavaL.*) Based Agroforestry System.

Abstract

The study was conducted during 2021-2022 during Rabi season in Mirzapur district, Uttar Pradesh (Vindhyan region) at the agroforestry system of Rajiv Gandhi South Campus, Department of Agronomy, Banaras Hindu University. The aim of this research was to analyse different level of NPK on the growth parameters, yield attributes and yield of linseed under guava based Agri-horticulture system. The experiment was laid out in randomized block design with nine treatments. Results indicated that increasing NPK levels positively impacted growth parameters and yield attributes of linseed. The highest NPK application (60-60-50 kg ha^{-1}) resulted in the most favourable outcomes.Economic analysis revealed that higher NPK concentrations led to increased gross returns, net returns, and benefit-cost ratio.Based on the findings, it is recommended to apply 60 kg N ha^{-1}, 30 kg P ha^{-1}, and 25 kg K ha^{-1} for optimal growth and yield of linseed under the guava-based Agri-horticulture system, leading to maximum net returns.

Introduction

Agroforestry is a sustainable land management system in which trees, shrubs, agricultural crops, and animals are simultaneously integrated on the same piece of land to increase yield (Nair 1990).As we all know, a growing population creates concerns about food security, malnutrition, health issues (e.g., anemia, chronic kidney disease, chronic liver disease, Wilkinson's disease), and uneven distribution of land for agriculture, forest, and industrialization, leading to environmental issues (e.g., global warming, land degradation, erosion).Thus, agroforestry systems can be used to overcome these issues. Many studies have been conducted to understand the effects of different agri-crops under different agroforestry systems (e.g., guava, custard apple, bael, pomegranate integrated with maize, leguminous crop, and cereals). India is the 2nd most populated country in the world, with a population density of 476.65 km^2.Land for agriculture has been reduced due to an increase in population growth rate and urbanization, which ultimately creates a pressure on nations' food security to fulfill the growing population demand. Agi-horticulture can be practiced to secure food grain production by sustainable use of land resources among fruit trees (5–6 years of initial growth), which markedly increases the net return per unit area per unit time (Gill and Bisaria, 1995).According to Gill and Gangwar (1992), interspaces of custard apple and aonla orchards can be exploited by intercropping grain and fodder crops during the initial years of fruit tree establishment.The guava-based agri-horti system is practiced not only for extra profit, but also for improved farmland by improving soil health and preventing soil erosion. Guava (Psidium guajava L.), a perennial tree belonging to the Myrtaceae family, is said to have originated in Central America and the southern part of Mexico.Due to its high nutritional value, it is an excellent fruit for nutritional security. It has a high nutritional value and is therefore a good fruit for ensuring nutritional security.Linseed, also known as "Alsi or Flaxseed," belongs to the family Lineaceace and is one of about 200 species in the genus Linum and is considered the most important pre-historic Rabi season crop in the world.Linseed occupies a greater importance, owing to its special qualities and various uses. Linseed is an important industrial and fiber-producing crop that is grown throughout the world, including India. Linseed is an annual small herbaceous plant that usually grows to a height of 30 to 120 cm. It has a hardy nature and a well-developed fibrous root system with numerous lateral roots. In India, linseed is primarily cultivated for its high-demand oil and fiber, which is extracted from mature seeds and stems. Every part of it is useful and very important. Oil derived from linseed is used in many industries either directly or after processing.During the crop period, Rabi oilseed requires moderate to cool temperatures and is one of the important Rabi oilseed crops of eastern Uttar Pradesh.The majority of linseed oil is used as a basic raw material for the production of a wide range of everyday products such as soaps, paints, and, printing inks, but only a limited amount is used for edible purposes. The oil content of linseed ranges between 37 and 42%. The oil cake of linseed is a precious feed for cattle, which is probably the most common. Linseed also has medicinal and therapeutic value. It contains a high amount of protein (36%) and is given to milch and fattening animals. It is used as organic manure in addition to feeding cattle because of its high nutrient content (N almost 5%, P 1.4%, and K 1.8%). Its seeds are high in omega-3 fatty acids (mostly ALA) and low in omega-6.Lignin, which contains plant estrogen and antioxidants, is one of the key components of linseed. Judicious application of nutrients such as nitrogen, phosphorous, and potash can increase crop productivity in agronomic practices.The selection of suitable varieties is one of the main factors in determining crop yield, and high-yielding cultivars can increase their productivity per unit area. The yield of linseed can be further increased by releasing new varieties or high-yielding varieties (HYV).Among the different fertilizers known to increase crop production in different agro-climatic zones, nitrogen is the most important fertilizer and is considered an important input in agriculture. Nitrogen plays an important role in linseed cultivation. Nitrogen is the main constituent of chlorophyll, which is responsible for the green color in plants and is the primary absorber of energy needed for photosynthesis. The application of phosphorus (P) and nitrogen (N) affects the growth and yield components of linseed. As a result of reduced numbers of tillers and fruiting branches per plant, the main effect of constant P stress on yield components was a reduction in the number of capsules per plant. Phosphorus-stressed plants required longer to reach seed maturity than plants that received high P. Phosphorus did not have a significant effect on single seed weight or seed oil concentration and did not have a significant effect on the number of seeds per capsule. Potassium is accountable for ensuring optimal plant growth. K activates dozens of important enzymes, such as protein synthesis, sugar transport, N and C metabolism, and photosynthesis. Therefore, it is important to identify the appropriate doses of chemical fertilization to increase the yield in a guava + linseed cropping system subject to the shading effect of guava.

MATERIALS AND METHODS:

The present study was conducted during the winter (rabi) season of 2021–22 at the research farm of Rajiv Gandhi South Campus, Barkachha, Mirzapur, which is in eastern Uttar Pradesh. The soil at the experimental site was acidic sandy clay loam, with low levels of organic carbon (SOC), nitrogen, and phosphorous (0.34%, 169.20, and 10 kg/ha, respectively), and medium potassium content (181.20 kg/ha). The average temperature, relative humidity, and sunshine hours during the trial period were 20°C, 64.5%, and 5.6 h, respectively, with a total rainfall of 31.2 mm. The experiment was conducted in a 12-year-old guava plantation planted in August 2006 at a spacing of 7 × 7 m^2. The linseed variety Padmini was used as the test crop, and the experiment was conducted in a randomized block design (RBD) with three replications under the guava-based Agri-horticulture system. Each replication consisted of 9 treatment combinations, and there were 27 plots, each measuring 2 × 2 m^2. The plot size was 9 rows by 30 × 30 cm, and the treatment combinations were as follows: control (no fertilizer), 0:30:25 kg $N:P_2O_5:K_2O$, 0:60:50 kg $N:P_2O_5:K_2O$, 30:0:0 kg $N:P_2O_5:K_2O$, 30:30:25 kg $N:P_2O_5:K_2O$, 30:60:50 kg $N:P_2O_5:K_2O$, 60:0:0 kg $N:P_2O_5:K_2O$, 60:30:25 kg $N:P_2O_5:K_2O$, and 60:60:50 kg $N:P_2O_5:K_2O$. Linseed seeds were sown manually at a rate of 30 kg/ha between the alleys of the guava trees in furrows.The growth parameters of the linseed, such as the number of plants per height, dry matter accumulation per plant, and number of green leaves per plant, were recorded at 30, 90, and 120 days after sowing (DAS), and the number of branches per plant was recorded at 60 DAS. Yield attributes and yield were recorded after the harvest of the test crop.

RESULT AND DISUCSSION

Effects on growth parameters of linseed:

Table 1 indicates the effect of NPK application on growth parameters such as plant height, number of branches per plant, number of leaves per plant, and dry matter accumulation per plant. As the levels of NPK increased from the control to 60–60–50 kg ha^{-1}, all these growth parameters improved progressively. Both the medium level (60-30-25 kg ha^{-1}) and the higher level (60-60-50 kg ha^{-1}) of NPK application were found to be significantly better than the lower level (30-30-25 kg NPK ha^{-1}).The increased availability of nitrogen, phosphorus, and potash in the soil resulted in vigorous vegetative growth of the plants, which reached their full potential in terms of plant height, leaf area, size, and photosynthesis rate. The formation of auxiliary and lateral branches is an example of tissue differentiation primarily regulated by nitrogen. In this study, the number of branches per plant also increased with higher rates of NPK application. Nitrogen plays a crucial role in auxin development, which promotes the growth of lateral buds that eventually develop into branches (Gregory and Veal, 1957). Similarly, phosphorus is essential for many vital plant growth processes, with energy storage and transfer being the most important. The increased supply of phosphorus, along with nitrogen and potassium, may have improved the energy use efficiency of plants, leading to increased branching and vigorous growth at medium levels of NPK application. Previous studies by Kalita et al. (2005), Saxena et al. (2005), Rahimi et al. (2011), Chopra and Badiyala (2016), and Dohat et al. (2017) have also reported similar trends in plant growth of linseed with increasing levels of NPK.

Table:1 Effect of different Levels of NPK on growth parameters of linseed under guava based Agri-horticulture system

Treatment	Plant height (cm)		Dry matter accumulation/plant (g)		Number of green leaves/plants		Number of branches/ plants	
	At 90 DAS	At Harvest	At 90 DAS	At Harvest	At 60 DAS	At 90 DAS	At 90 DAS	At Harvest
T1($N_0P_0K_0$)	38.31	37.58	5.30	5.39	121.87	298.27	4.60	4.46
T2($N_0P_{30}K_{25}$)	39.44	39.17	5.46	5.68	125.38	305.66	4.77	4.57
T3($N_0P_{60}K_{50}$)	40.22	40.04	5.58	5.69	132.14	314.60	4.90	4.74
T4($N_{30}P_0K_0$)	41.21	40.93	5.69	5.80	137.35	325.69	5.07	4.99
T5($N_{30}P_{30}K_{25}$)	42.23	42.25	5.78	5.86	142.24	333.69	5.20	5.32
T6($N_{30}P_{60}K_{50}$)	42.48	42.14	5.92	5.99	145.82	345.48	5.45	5.66
T7($N_{60}P_0K_0$)	43.73	43.50	6.18	6.43	150.68	350.66	5.75	5.84
T8($N_{60}P_{30}K_{25}$)	44.58	44.36	6.45	6.85	159.08	358.29	5.97	6.28
T9($N_{60}P_{60}K_{50}$)	45.20	44.57	6.54	7.09	159.67	359.80	6.05	6.43
S.Em	0.40	0.27	0.07	0.14	1.78	2.21	0.12	0.18
CD	1.16	0.79	0.21	0.39	5.19	6.46	0.34	0.53

Effect on yield attributes and yield of linseed:

Table 2 shows the number of capsules plant^{-1}, number of seeds per capsule $^{-1}$, and seed weight. Distinct positive effects of NPK levels were observed on these yield attributes. All these characteristics attained higher values with increasing NPK application levels from 60–60 to 50 kg ha^{-1}. The results are in accordance with the findings of Karwasra et al. (2006), Kushwaha et al. (2006), Sune et al. (2006), Awasthi et al. (2011), Homayouni et al. (2013), Singh et al. (2013), and Leilah et al. (2018). NPK levels of 60–60–50 kg ha^{-1} produced maximum seed yield due to its favourable effect on capsules plant^{-1}, seed capsule $^{-1}$, and test weight. Vashishtha (1993), Agarwal et al. (1997) and Dwivedi et al.(2000) reported an increase in seed yield with increasing NPK levels. Straw yield as a function of vegetative growth Increasing NPK levels up to 60–60–50 kg ha^{-1} augmented plant height, green-leaf plant^{-1}, branch plant^{-1}, and dry matter production, which ultimately resulted in higher stover yield. This finding is consistent with the results of Samui et al. (1995), Agarwal et al. (1997), Dwivedi et al. (2000), Singh et al. (2013), Eldaiem et al. (2015), EL-Shimy et al. (2017), and Gedwy and Mohamed (2020). Increased nitrogen, phosphorus, and potassium levels significantly enhanced linseed biological yield and harvest index. The application of 60–60–50 kg NPK ha^{-1} resulted in significantly higher biological yield.

Table:2 Effect of different Levels of NPK on yield attributes and yield of linseed under guava based agri-horticulture system

Treatment	Number of Capsules per plant	Number of seeds per capsule	Test Weight(g)	Grain Yield (kg ha-1)	Straw Yield (kg ha-1)	Biological Yield (kg ha-1)	Harvest Index (%)
T1($N_0P_0K_0$)	34.90	5.82	4.47	753.33	1891.00	2644.33	28.47
T2($N_0P_{30}K_{25}$)	35.83	5.95	4.62	763.00	1913.67	2676.67	28.50
T3($N_0P_{60}K_{50}$)	37.09	6.17	4.79	785.00	1972.00	2757.00	28.48
T4($N_{30}P_0K_0$)	37.85	6.51	5.07	783.00	1962.33	2745.33	28.52
T5($N_{30}P_{30}K_{25}$)	39.16	6.73	5.49	810.67	2032.67	2843.33	28.51
T6($N_{30}P_{60}K_{50}$)	40.63	6.91	6.33	900.33	2256.00	3156.33	28.51
T7($N_{60}P_0K_0$)	41.73	7.38	6.97	956.67	2398.67	3355.33	28.51
T8($N_{60}P_{30}K_{25}$)	42.48	8.14	8.09	1025.33	2572.33	3597.67	28.50
T9($N_{60}P_{60}K_{50}$)	42.70	8.33	8.18	1047.67	2625.67	3673.33	28.52
S.Em	0.28	0.22	0.28	10.82	27.48	38.28	0.02
CD	0.81	0.63	0.81	31.57	80.22	111.75	0.05

Effect on Economics of linseed:

Table 3 shows the effect of nitrogen, phosphorus, and potassium levels on the economics of linseed. It was noted that the economics of linseed was greatly influenced by nitrogen, phosphorus, and potassium levels. Variation in cultivation cost resulted in different production costs. The cost of cultivation increases with increasing nitrogen, phosphorus, and potassium concentration. However, there was a maximum of 60 kg N ha^{-1}- 60 kg P ha^{-1}- 50 kg K ha^{-1} for nitrogen, phosphorus, and potassium. Increases in nitrogen, phosphorus, and potassium concentrations from the lowest to the highest significantly improved gross returns, net returns and benefit cost ratio. This can be attributed to the fact that the application of nitrogen, phosphorus, and potassium from lowest to highest increased the yield of linseed. These results are consistent with the experimental findings of Dilenssie et al. (2020), Parmar et al., and Narayana et al.

Table:3 Effect of different levels of NPK on of linseed under guava based agri-horti system.

Treatment	Treatment cost of cultivation	Gross return ha^{-1}	Net return	Benefit cost ratio
T1($N_0P_0K_0$)	35497	130408	94911	2.67
T2($N_0P_{30}K_{25}$)	38496	130965	92469	2.40
T3($N_0P_{60}K_{50}$)	41495	132249	90754	2.18
T4($N_{30}P_0K_0$)	35753	132123	96370	2.69
T5($N_{30}P_{30}K_{25}$)	38753	133694	94941	2.45
T6($N_{30}P_{60}K_{50}$)	41752	139442	97690	2.33
T7($N_{60}P_0K_0$)	36006	142164	106158	2.64
T8($N_{60}P_{30}K_{25}$)	39005	146169	107164	2.74
T9($N_{60}P_{60}K_{50}$)	42004	147441	105437	2.51

CONCLUSION

Based on the research conducted at Rajiv Gandhi South Campus, Barkachha, Mirzapur, BHU, it could be deduced from this investigation that the application of 60 kg N ha^{-1}, 30 kg P ha^{-1}, and 25 kg K ha^{-1} significantly increased all the growth and yield parameters compared with all the treatments but at par with T9 (60 kg N ha^{-1}, 60 kg P ha^{-1}, and 50 kg K ha^{-1}). Therefore, it may be recommended to supplement linseed (variety PADMINI) with 60–30–25 kg NPK ha^{-1}(T8) under the guava-based Agri - Horti system to achieve the maximum net return.

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