

Research Application Summary

**Identification of appropriate production packages for increased African nightshade production in Kisii County, Kenya**

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**Abstract**

This study investigated the effects of intercropping arrangements and fertiliser combinations on growth and yields of African nightshade (*Solanum nigrum* L.). The study was carried out at the Kenya Agricultural and Livestock Research Organization (KALRO) Kisii County. The experiment were laid out in a complete randomized block design with a split plot arrangement replicated three times. The main plots were intercropping arrangements (intercrop ratios of 0:16, 1:14, 1:2, 1:3, and 1:4). The sub plots were fertilizer combinations of Farm yard manure (FYM), urea and triple super phosphate (TSP) comprising of; FYM (60 kg N ha<sup>-1</sup>+ 36 kg P ha<sup>-1</sup>), urea (60 kg N ha<sup>-1</sup>) + TSP (40 kg P ha<sup>-1</sup>), urea (30 kg N ha<sup>-1</sup>) + TSP (20 kg P ha<sup>-1</sup>) + FYM (30 kg N ha<sup>-1</sup> + 18 kg P ha<sup>-1</sup>), urea (20 kg N ha<sup>-1</sup>) + TSP (10 kg P ha<sup>-1</sup>) + FYM (40 kg N ha<sup>-1</sup>+ 27 kg P ha<sup>-1</sup>), urea (40 kg N ha<sup>-1</sup>) + TSP (30 kg P ha<sup>-1</sup>) + FYM (20 kg N ha<sup>-1</sup>+ 9 kg P ha<sup>-1</sup>). Data on total fresh leaf yield of African nightshade (ANS) was measured. There was a significant (P=0.05) interaction effect between intercropping arrangements and fertiliser combinations in fresh leaf yield. The sole ANS supplied with Urea (60kg N ha<sup>-1</sup>) + TSP (40kg P ha<sup>-1</sup>) and urea (40kg N ha<sup>-1</sup>) + TSP (30kg P ha<sup>-1</sup>) + FYM (20kg N ha<sup>-1</sup>+ 9 kg P ha<sup>-1</sup>) resulted in the highest fresh leaf yield (35.1 t ha<sup>-1</sup>and 32.5 tons ha<sup>-1</sup> respectively) followed by an intercrop ratio of 1:14 (ANS with spider plants along the borders) supplied with urea (60kg N ha<sup>-1</sup>) + TSP (40Kg P ha<sup>-1</sup>) and urea (40 kg N ha<sup>-1</sup>) + TSP (30kg P ha<sup>-1</sup>) + FYM (20kg N ha<sup>-1</sup>+ 9 kg P ha<sup>-1</sup>) that resulted in 29.3 tons ha<sup>-1</sup> and 27.3 t ha<sup>-1</sup> respectively. An intercrop ratio of 1:2 supplied with urea (20kg N ha<sup>-1</sup>)+ TSP (10kg P ha<sup>-1</sup>) + FYM (40kg N ha<sup>-1</sup>+ 27kg P ha<sup>-1</sup>) and FYM (60kg N ha<sup>-1</sup>+ 36 kg P ha<sup>-1</sup>) resulted in the lowest fresh leaf yield (10.1 tons ha<sup>-1</sup> and 8.9 tons ha<sup>-1</sup> respectively) which was not significantly different from an intercrop ratio of 1:4 supplied with FYM (60kg N ha<sup>-1</sup>+ 36 kg P ha<sup>-1</sup>) (9.2 t ha<sup>-1</sup>).

Key words: Farm yard manure, inorganic fertilizer, *Solanum nigrum*, spider plant

## Résumé

La présente étude a investigué les effets de culture mixte et combinaisons d'engrais sur la croissance et la productivité de la morelle de Guinée (*Solanum nigrum* L.). L'étude a été effectuée à l'Organisation de la Recherche agricole et de l'élevage du Kenya (KALRO) commune de Kisii. L'expérimentation était conduite suivant un dispositif de bloc aléatoire complet répété trois fois. Les principales parcelles étaient les arrangements de culture mixte ( ratios de 0:16, 1:14, 1:2, 1:3 et 1:4). Les sous-parcelles étaient les combinaisons d'engrais de terreau (FYM), urée et le triple super phosphate (TSP) composé de FYM (60 kg N ha<sup>-1</sup>+ 36 kg P ha<sup>-1</sup>), urée (60 kg N ha<sup>-1</sup>) + TSP (40 kg P ha<sup>-1</sup>), urée (30 kg N ha<sup>-1</sup>) + TSP (20 kg P ha<sup>-1</sup>) + FYM (30 kg N ha<sup>-1</sup>+ 18 kg P ha<sup>-1</sup>), urée (20 kg N ha<sup>-1</sup>)+ TSP (10 kg P ha<sup>-1</sup>) + FYM (40 kg N ha<sup>-1</sup>+ 27 kg P ha<sup>-1</sup>), urée (40 kg N ha<sup>-1</sup>) + TSP (30 kg P ha<sup>-1</sup>) + FYM (20 kg N ha<sup>-1</sup>+ 9 kg P ha<sup>-1</sup>). Les données étaient mesurées sur la productivité totale de morelle de Guinée (ANS). Il y avait un effet significatif ( $p=0.05$ ) de l'interaction entre arrangement de culture mixte et combinaisons d'engrais sur la productivité de fraîche feuille. La monoculture de ANS supplémentée par Urée (60kg N ha<sup>-1</sup>) + TSP (40kg P ha<sup>-1</sup>) et Urée (40kg N ha<sup>-1</sup>) + TSP (30kg P ha<sup>-1</sup>) + FYM (20kg N ha<sup>-1</sup>+ 9 kg P ha<sup>-1</sup>) a donné le rendement le plus élevé de fraîche feuille (35.1 t.ha<sup>-1</sup> et 32.5 t.ha<sup>-1</sup> respectivement) suivie du ratio de culture mixte de 1:14 (ANS avec la plante araignée le long du pourtour) supplémenté avec Urée (60kg N ha<sup>-1</sup>) + TSP (40Kg P ha<sup>-1</sup>) et urée (40 kg N ha<sup>-1</sup>) + TSP (30kg P ha<sup>-1</sup>) + FYM (20kg N ha<sup>-1</sup>+ 9 kg P ha<sup>-1</sup>) qui a donné un rendement de 29.3 t.ha<sup>-1</sup> et 27.3 t.ha<sup>-1</sup> respectivement. Le ratio de culture mixte de 1:2 supplémenté avec Urée (20kg N ha<sup>-1</sup>) + TSP (10kg P ha<sup>-1</sup>) + FYM (40kg N ha<sup>-1</sup> + 27kg P ha<sup>-1</sup>) et FYM (60kg N ha<sup>-1</sup>+ 36 kg P ha<sup>-1</sup>) a donné le plus faible rendement en fraîche feuille (10.1 t.ha<sup>-1</sup> et 8.9 t.ha<sup>-1</sup> respectivement) lequel était significativement différent du ratio de culture mixte supplémenté avec FYM (60kg N ha<sup>-1</sup>+ 36 kg P ha<sup>-1</sup>) (9.2 t ha<sup>-1</sup>).

Mots-clés : Engrais inorganique, *solanum nigrum*, plante araignée

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## Background

African nightshade (*Solanum nigrum*) is one of the leafy vegetables in the solanaceae family, largely domesticated in sub-Saharan Africa (Abukusta-Onyango *et al.*, 2004). It is known because of its nutritional, medicinal value and a source of livelihood; rich in iron, calcium, vitamins A and C (Yang *et al.*, 2009). Its production is however, hampered by low soil fertility, pests and diseases. The use of inorganic fertiliser alone has not been helpful in production of the African nightshade because it aggravates degradation of soil, though they contribute to higher yield in comparison with organic manure alone (Achieng *et al.*, 2010). Continuous use of inorganic fertiliser as the main source of nutrients leads to rapid decline in crop yields because of acidification and soil compaction (Achieng *et al.*, 2010). The use of integrated nutrient management is a sound soil fertility management strategy in many countries of the world. Most of the

smallholder farmers produce indigenous vegetables using either inorganic or organic fertilisers with different intercropping patterns (Ademba *et al.*, 2015). However they do not pay attention to pest and disease management neither do they attempt to optimise fertiliser use. It is therefore, envisaged that intercropping spider plant and African nightshade with the right combination of fertilisers will improve soil fertility and increase African nightshade productivity. This will ultimately empower smallholder farmers economically. The study reported in this paper was undertaken to contribute towards enhanced African nightshade production and utilization in smallholder farming systems.

### **Study description**

The study was conducted in Kisii County, Kenya (longitudes: 34° 46' E and latitudes: 0° 41' S). The area receives mean annual rainfall of 1500mm with the long rains between March and June while the short rains are received from September to November. The area experiences a maximum temperature of 30°C and minimum temperature of 15°C. The soils are well drained with red volcanic soils which are deep in organic matter (Soil handbook of Kenya, 2000). Main economic activities of the inhabitants of Kisii are vegetable farming, small scale trade, dairy farming, tea and coffee growing, commercial businesses and soapstone carvings.

### **Experimental design and treatments**

The experiment was laid in a randomized complete block design with three replications with a split plot arrangement replicated three times. The main plots consisted of intercropping arrangements;(i) sole African nightshade, (ii) spider plant surrounding 14 rows of African nightshade (1:14), (iii) one row of spider plant intercropped with 2 rows of African nightshade (1:2), (iv) one row of spider plant intercropped with 3 rows of African nightshade (1:3) and (v) one row of spider plant intercropped with 4 rows of African nightshade (1:4). The subplots consisted of fertiliser combinations of Farm yard manure (FYM), urea (NPK: 46-0-0) and triple super phosphate (TSP) (NPK: 0-46-0) applied as FYM (60 kg N ha<sup>-1</sup>+ 36 kg P ha<sup>-1</sup>), urea (60 kg N ha<sup>-1</sup>) + TSP (40 kg P ha<sup>-1</sup>), urea (30 kg N ha<sup>-1</sup>) + TSP (20 kg P ha<sup>-1</sup>) + FYM (30 kg N ha<sup>-1</sup>+ 18 kg P ha<sup>-1</sup>), urea (20 kg N ha<sup>-1</sup>)+ TSP (10 kg P ha<sup>-1</sup>) + FYM (40 kg N ha<sup>-1</sup>+ 27 kg P ha<sup>-1</sup>), or urea (40 kg N ha<sup>-1</sup>) + TSP (30 kg P ha<sup>-1</sup>) + FYM (20 kg N ha<sup>-1</sup>+ 9 kg P ha<sup>-1</sup>). At planting urea and triple superphosphate were banded together while farm yard manure was applied two weeks prior to planting at rates that depended on the treatment for each plot.

### **Agronomic practices**

The plots were ploughed and harrowed before planting the crops. Five seeds were sowed directly and thereafter thinned to achieve a spacing of 15cm between plants and 30 cm between rows giving a total of 16 rows. At planting urea and tri-superphosphate were banded together while farm yard manure was applied two weeks prior to planting to those plots that were receiving both inorganic fertiliser and farm yard manure. Hand weeding was done regularly to ease competition from weeds and the crop solely depended on rainfall.

### Data collection and analysis

Five plants from each sub plot were tagged for data collection. Data collection for all variables started at week five until the eleventh week after planting when crop yields declined. Statistical analysis on number of branches per plant and total fresh leaf yield measured were subjected to analysis of variance (ANOVA) using GENSTAT version 15 (Payne *et al.*, 2011).

### Results

#### Fresh leaf yield

There was a significant ( $P=0.05$ ) interaction effect between fertiliser combinations and intercropping arrangements on the total vegetable fresh weight (Table 1). The sole African nightshade (0:16) supplied with a fertiliser combination of urea (60 kg N ha<sup>-1</sup>) + triple superphosphate (40 kg P ha<sup>-1</sup>) resulted in the highest fresh leaf yield of 35.1 t ha<sup>-1</sup>. This was not significantly different from that obtained when African nightshade was supplied with urea (40 kg N ha<sup>-1</sup>) + triple superphosphate (30 kg P ha<sup>-1</sup>) + FYM (20 kg N ha<sup>-1</sup>+ 9 kg P ha<sup>-1</sup>) (32.5 t ha<sup>-1</sup>) under the same intercropping arrangement (Table 1). These were followed by an intercrop ratio of 1:14 (spider plant grown on the border rows) supplied with either urea (60kg N ha<sup>-1</sup>) + triple superphosphate (40kg P ha<sup>-1</sup>) (29.3 t ha<sup>-1</sup>) or supplied with urea (40kg N ha<sup>-1</sup>) + triplesuperphosphate (30kg P ha<sup>-1</sup>) + FYM (20kg N ha<sup>-1</sup>+ 9 kg ha<sup>-1</sup>) (27.3 t ha<sup>-1</sup>). Growing of African nightshade at an intercrop ratio of 1:2 supplied with FYM (60 kg N ha<sup>-1</sup>+ 36 kg P ha<sup>-1</sup>) resulted in the lowest fresh leaf yield of 8.9 tons ha<sup>-1</sup> however, this was not significantly different from 1:3 and 1:4 intercrop ratios with the same fertiliser combinations that recorded 12.2 t ha<sup>-1</sup> and 9.2 tons ha<sup>-1</sup>, respectively (Table 1).

Table1: Effect of intercropping arrangements and fertilizer combination on fresh leaf yield (t /ha) of African nightshade (*Solanum nigrum* L.)

Fertilizer combinations	FRESH LEAF YIELD (tons ha <sup>-1</sup> )				
	Intercropping arrangements (Spider plant: African nightshade)				
	Sole ANS	1:14(SP as border )	1:3	1:2	1:4
60kgN/ha urea + 40kgP/ha TSP	35.1a	29.3bc	21.8ef	18.2fgh	23.8de
40kgN/ha urea + 30kgP/ha TSP+20kgN/ha FYM	32.5ab	27.3cd	21.3efg	15.9hij	23.5de
30kgN/ha urea + 20kgP/ha TSP+30kgN/ha FYM	21.7efg	17.8ghi	15.0hijk	11.8kl	16.4hi
20kgN/ha urea + 10kgP/ha TSP+40kgN/ha FYM	18.7fgh	17.3hi	14.0ijk	10.0l	15.9hij
60kgN/ha farm yard manure	15.8hij	15.1hijk	12.2jkl	8.9l	9.2l

LSD=3.85

N=15. FYM-farm yard manure, TSP-Triple superphosphate, Means followed by the same letter(s) is not significantly different ( $P\leq 0.05$ ).

During growth and development, vegetable plants intercept and absorb light, water and nutrients and use them to produce biomass (Mohamed *et al.*, 2007). Farm yard manure releases of soil nutrients slowly for plant uptake; however the residual benefits of farm yard manure on the soil physical and biological properties. In this study, sole African

nightshade supplied with either urea ( $60 \text{ kg N ha}^{-1}$ ) + triple superphosphate ( $40 \text{ kg P ha}^{-1}$ ) or urea ( $40 \text{ kg N ha}^{-1}$ ) + triple superphosphate ( $30 \text{ kg P ha}^{-1}$ ) + FYM ( $20 \text{ kg N ha}^{-1} + 9 \text{ kg P ha}^{-1}$ ) recorded the highest total fresh leaf yield. The intercrops with more rows of spider plant across fertiliser combinations recorded low yields compared to sole African nightshade. This could be attributed to competition for available nutrients,  $\text{CO}_2$  and light. These results agree with those of Mohamed *et al.* (2007) working on okra, who reported that intercropping okra with cucumber significantly reduced the fruit yield of cucumber compared to the respective mono crops. Further, Mahadeem *et al.* (2008) working with broccoli, reported that inorganic fertiliser produced the highest yields compared to the corresponding amounts of organic manure. Even though there was no yield benefits exhibited in African nightshade after intercropping with spider plant, there is a possibility that the combined yield obtained from different spider plant: African nightshade intercropping system for both vegetables could be greater than for mono-cropped African nightshade.

## Conclusion

Application of urea ( $60 \text{ kg N ha}^{-1}$  urea + TSP ( $40 \text{ kg P ha}^{-1}$ ) resulted in the highest number of branches per plant but reduction of the inorganic fertiliser by 25% and supply of the deficit from farm yard manure resulted in the same number of branches. The same trend was evident in the leaf yield but higher in sole ANS and an intercrop ratio of 1:14 and 1:4 and this is likely to reduce environmental pollution given the fact that organic fertilisers releases nutrients slowly. Over a long period of time, combined fertiliser application will play an important role in sustainable production of the two vegetables.

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