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Influence of Cowpea Lines As Green Manure on Growth and Yield of Carrots in Root-Knot Nematode Infested Soil

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ABSTRACT
An experiment was conducted at the University of Education, Winneba, Mampong-Ashanti campus to determine the effect of some cowpea lines as green manure on the growth and yield of carrot in root-knot nematode infested soil. Randomized complete block design with five treatments and four replications was used. The treatments were cowpea lines IT97K-570-18; IT97K-566-18; and IT00K-1150 as green manure, N.P.K (15, 15, 15) and control. The results showed negative correlation between root-knot nematode infestation and growth and yield parameters of carrot. The various cowpea green manure treatments and NPK (15, 15, 15) fertilizer significantly ($p<0.05$) improved the vegetative growth of carrot plants. Carrots from plots incorporated with cowpea line IT97K-570-18 produced significantly higher root yield than the control. Root-knot nematode infestation on carrot was lowest from plots incorporated with line IT97K-570-18. For all the parameters studied, carrot plants produced from plots incorporated with line IT97K-570-18 green manure gave the best results with respect to growth and yield. It also reduced the severity of galling. The results suggest that line IT97K-570-18 can be a better alternative to NPK (15, 15, 15) for increased carrot yield and root-knot nematode control on the Bediese Soil Series of Ghana.
Key Words: Cowpea, Green manure, Carrot, Root Knot Nematodes and UEW.

INTRODUCTION

Carrot (*Daucus carota*) is a biennial but usually grown as annual crop in the tropics. The crop belongs to the family Umbelliferae and the edible root contains carotene, vitamin A. and appreciable quantities of thiamine and riboflavin (Tweneboah, 1997). Carrot is an aromatic herb with diuretic and digestive properties, useful to stimulate uterus with anti cancer properties and it increases the flow of urine. It improves eyesight as well as skin health due to its high amount of beta-carotene. Essential oil extracted from carrots is excellent body purifier which boost the functions of the liver, improves digestion and promotes the formation of red blood corpuscles. It also slows down ageing process, and it is used to control ulcers, eczema, boil and in cosmetic preparations to fight wrinkles (Ageless, 2009). Varieties cultivated in Ghana include Amsterdam Grace, Amsterdam Forcing, Nantes, Superior Chantenay, Cape and Kuroda improved (Tindall, 1983).

Carrot has relatively high demand for soil nutrients especially potassium and nitrogen (William *et al*., 1991; Bendel *et al,* 1992). This necessitates the application of various soil amendments for maximum growth and yield especially where the soil is under continuous cropping. Bumb and Baanite (1996) reported that failure to replenish poor tropical soils can initiate soil degradation, which will ultimately lead to severe crop losses resulting in poverty, hunger and malnutrition. The misuse of inorganic fertilizers can also lead to either soil acidity or alkalinity.

An alternative to the use of inorganic fertilizers is the application of organic soil amendments including green manuring which apart from improving soil fertility is also environmentally friendly. These have many advantages, especially for the resource poor farmer in a developing country like Ghana where most farmers cannot afford expensive mineral fertilizers due to their high cost.

Agboola and Fayemi (1972) reported that cowpea as green manure is an important source of N for many crops in the humid tropics. When properly managed, cowpea can produce 20 to 40 tonnes per hectare fresh biomass which when incorporated into the soil as green manure can add up to 45-68kgN per year (Tucker and Matlock, 1974).

Root-Knot nematode infestation which has been identified as one of the major causes of low yield of carrots (Tindall, 1983) can lead to up to 45% yield loss (Widmer *et al*, 2001). According to Leonard (1981) root knot nematodes attack on root crops such as carrot results in forked and twisted roots which are often rejected by consumers. The objective of the study was to determine the effect of different cowpea lines as a green manure crop on growth and yield of carrot in root-knot nematode infested soil.

MATERIALS AND METHODS

The experiment was carried out at the College of Agriculture Education, University of Education Winneba,

Mampong- Ashanti campus from April to October, 2008. The soil of the area is described locally as Bediese Series and internationally as Chromic Luvisol. The soil is sandy-loam, well drained and with thin layer of organic matter (SRI, 1999). It has characteristic deep yellowish red colour, friable and is free from stones. The P^H of the soil is 6.5-7.0 (SRI, 1999) and it is permeable with moderate water holding capacity (Asiamah *et al.*, 1993).

Randomized Complete Block Design was used with five treatments in four replications. Each block measured 14mx2m with 1m path separating the blocks and plots. Seeds of three erect and determinate cowpea lines, obtained from Crops Research Institute, Fumesua, Kumasi were used in the study. The lines had an average dry matter of 7.36-11.83t/ha and nitrogen fixation potential of 37.13-37.77KgN/ha. The treatments were green manure of cowpea lines ITOOK-1150, IT97K-566-18 and IT97K-570-18, NPK (15; 15; 15) and control. Three cowpea seeds were sown per hill at a spacing of 60cm x20 cm and thinned to two plants per hill one week after germination. Cowpea plants on each plot were incorporated into the soil with hoe 35 days after sowing and allowed for 30 days for decomposition. The NPK (15-15-15) fertilizer was applied at 300kg/ha 21 days after sowing. Beds measuring 2m x 2m were prepared with a hoe to a height of 25cm and leveled with rake. Seeds of carrot *var Kuroda improved* were sown by drilling to a depth of about 2cm and 25cm between rows on each bed. The beds were shaded with palm fronds and watered daily. Germination was observed six days after sowing and the palm fronds were used to raise a shed (50cm) to reduce the intensity of the sun on the young seedlings. The seedlings were thinned 10 days after germination to intra-row spacing of about 10cm. Weeds were handpicked with the aid of a hand fork. The inter-rows were stirred up with hand fork at two weeks intervals throughout the growing period to improve aeration and root development. Root shoulders which were exposed to the sun were earthed up in the process of stirring to prevent the greening of the root shoulders.

Twenty plants on each plot were randomly selected from the middle rows and tagged for record taking. Data on plant height and number of leaves were recorded at 4, 8, and 12 weeks after sowing (WAS). Plant height was measured with a meter rule from the soil level to the tip of the longest leaf, while number of leaves per plant was counted. Root length and diameter at 2cm from the root top were recorded immediately after harvest with the aid of a meter rule and veneer calipers respectively. Plants were gently uprooted with the aid of a hand trowel. The roots were washed gently in a bucket of water to remove soil particles. The roots were immersed in clean water in a glass measuring cylinder. This allowed a clearer view of both the main root and the feeder roots. Each root was observed carefully for root-knot nematode galls and assessed on a scale of 0-10 as described by Bridge and Page (1980).

The average score was recorded per plant for each treatment. Root yield from each plot were determined with an electronic balance. Number of forked roots on each plot was also counted.

RESULTS AND DISCUSSION

Vegetative Growth of Carrots

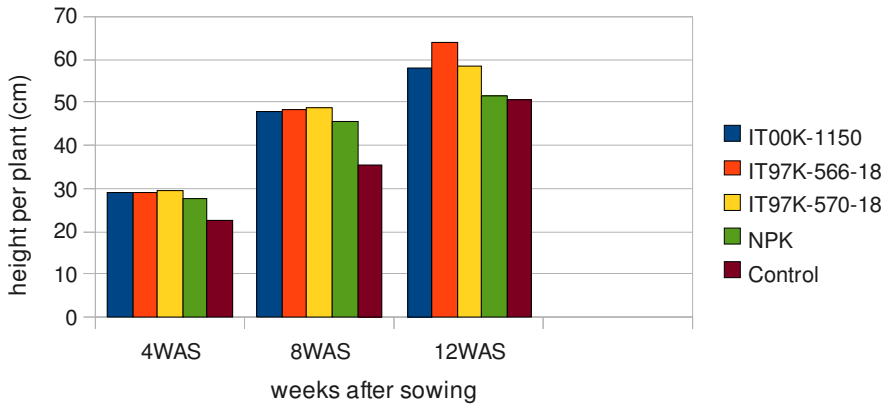

Figure 1: Influence of different soil amendment on Plant height

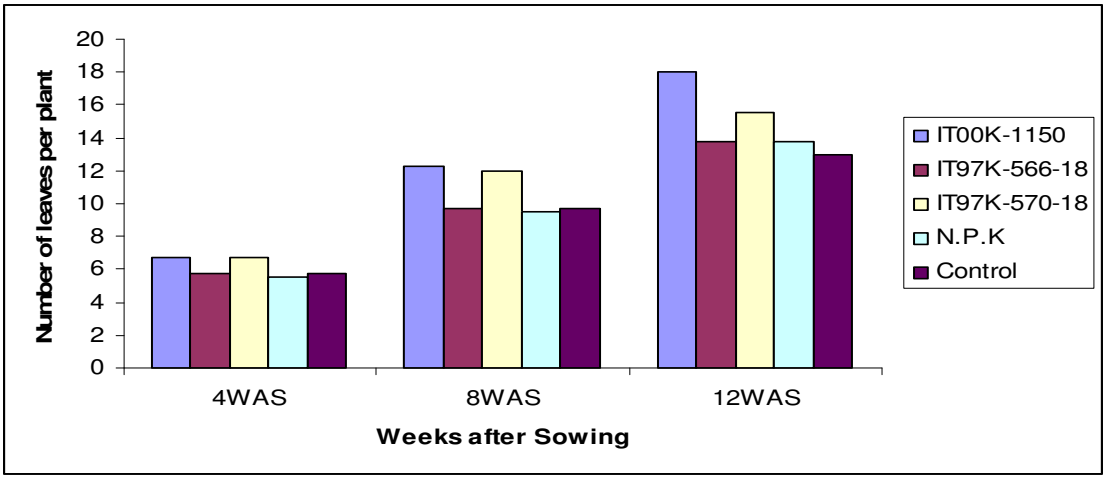

Figure 2: Influence of different soil amendments on number of leaves

Significant ($p<0.05$) differences in carrot plant height were observed at 4, 8, and 12 weeks after sowing. (figure1). Plots incorporated with IT97K-570-18 green manure produced the tallest carrot plants at 4 and 8 weeks after sowing (29.45 and 48.89cm) whilst the control produced the shortest plants (22.85 and 35.69cm). Plots incorporated with IT97K-566-18 green manure produced carrot plants which were significantly taller than those from the N.P.K and the control plants at 12 weeks after sowing (figure 1).
It was observed that line IT00K-1150 produced the highest number of leaves whilst the control `produced the least number of leaves at 12 weeks (Fig 2). It was likely that apart from improving the levels of soil nutrients, the green manure increased the soil organic matter and improved the soil physical properties which resulted into improved vegetative growth of the carrot. Allison (1973) observed that major benefit obtained from cowpea green manure is the addition of organic matter to the soil. The contribution of organic matter to the soil from the green manure is estimated to be 9 to 13 tonnes farmyard manure per hectare. Schmid and Klay (1984) stated that the most obvious direct economic benefit derived from cowpea green manure is nitrogen fertilizer saving.

Influence of different soil amendments on yield and root-knot nematode infestation of carrot
The largest root shoulder diameter (5.73cm) was recorded for IT97K-570-18 whilst the least root diameter (4.82cm) was found in the control plants (Table 1). It was observed that the treatments did not significantly affect root length even though the diameter of the roots varied significantly ($p<0.05$). IT97K-570-18 produced the highest yield (15.66t/ha) whilst control produced the lowest (3.80t/ha). Yield from cowpea green manure treated plots were similar to that of N.P.K but it was significantly higher than the control. As the lines were not allowed to grow to pod forming stage, the total nitrogen fixed was concentrated in the residue, and its addition to the soil resulted in increased nitrogen in the soil. In addition, cowpea residue decomposition releases other plant nutrients such as phosphorous, potassium, calcium, magnesium and sulphur into the soil. (Hoyt, 1987). When green manure is incorporated and allowed to decompose, plant nutrients become readily available in the soil for the succeeding crop resulting in improved growth and yield of the succeeding crop (Hoyt, 1987). This might have accounted for the higher yields of carrots from cowpea green manure compared to control.

The agronomic performance of carrot in this study showed that cowpea as green manure crop increases the yield of carrots. There was a positive correlation between the amounts of nitrogen fixed by the cowpea lines and the growth and yield parameters of carrots. Jones *et al* (1985) reported that green-manure crops when incorporated into the soil promotes high biological activity making plant nutrients available for crops uptake and this improves crop yield. Reports of some studies have shown that legume green manure can replace a portion of the nitrogen fertilizer requirements for a succeeding crop (Frye and Blevins, 1989).

Table 1: Effects of cowpea Green Manure on Yield and Root-Knot Nematode Infestation of Carrots

Treatment	Root diameter (cm)	Root length (cm)	Root weight (g)	Yield (t/ha)	Number of forked carrots	Galling Rating (0-10)
IT00K-1150	5.51	17.19	76.35	15.26	4.00	2.50
IT97K-566-18	5.48	17.15	73.80	15.55	3.00	3.50
IT97K-570-18	5.73	16.92	73.00	15.66	3.75	2.00
N. P. K	5.38	17.28	69.40	9.67	4.00	4.00
Control	4.82	16.34	50.05	3.80	5.50	5.25
LSD (0.05)	0.46	1.84	22.33	6.33	2.34	1.24
CV (%)	5.59	7.05	21.15	24.31	27.45	23.37

Root-knot nematode infestation

Carrot plants produced without any soil amendment had the highest (5.25) root-knot nematode galling. Carrots produced from beds treated with IT97K-570-18 had the lowest number of forked roots with control producing the highest. The decomposition of incorporated cowpea lines in the soil might have increased the number of antagonistic organisms and formation of nematicidal compounds which suppressed root-knot nematode populations and hence reduced the severity of galling on carrot roots (Sikora and Fernandez, 2005). Positive correlation (r=0.65) between root-knot nematode infestation and the number of forked carrot roots suggests that higher root- knot nematode infestation exposes carrots to the development of multiple root tips. Similar observation was made by Leonard (1981) who reported that root knot nematodes causes forking, misshaping, and twisting of roots which may be rejected by consumers.

Table 2: Correlation between root-knot nematode Infestation and growth and yield parameters of carrots.

Correlation (Linear)	Correlation coefficient (r)
nematode infestation vs. plant height(12WAS)	-0.55
nematode infestation vs. leaf number(12WAS)	-0.35
nematode infestation vs. root diameter	-0.94
nematode infestation vs. root length	-0.56
nematode infestation vs. root weight	-0.85
nematode infestation vs. forked roots	0.65
nematode infestation vs. total yield	-0.94

CONCLUSION

The findings of the study have shown that incorporation of cowpea as green manure promoted plant growth and increased yield of carrots compared to non application of any soil treatment. Green manure especially IT97K-570-18 produced better growth and yield of carrots than the other treatments. The incorporation of cowpea as green manure further reduced the severity of root galling and improved the quality of carrot roots.

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