

Dodder infestation on Tea in Nandi County, Kenya

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Abstract: *Dodders are holoparasites belonging to the family Convolvulaceae of the genus Cuscuta. Globally, about 200 species are reported to be a threat to crops of economic importance. Of major concern in counties of Kenya, are the impacts of parasitic dodder (Cuscuta spp.) on tea cultivation and production. This study aimed to assess the extent of dodder infestation on tea in Nandi County. An exploratory survey design was chosen for this study. The Yamane sampling formula obtained the sample size for the study. A semi-structured questionnaire was administered to 354 respondents from the Kenya Tea Development Agency to represent small-scale and the multinational tea estate to represent large-scale tea farming. Coordinates were captured on the farms with dodder, recorded on an observation checklist, analyzed, and presented on a map. Results obtained showed that 99.4% of the respondents knew about dodder. 205 (58%) respondents didn't have dodder on their tea farms while 149 (42%) reported the presence of dodder in their tea farms. In the Multinational tea estates, Siret, Chemomi, and Taito reported cases of dodder infestation. Notably, 74.9% of the respondents recorded that children were the major agents of dodder spread. 97.7% of the respondents acknowledged that dodder is a threat to tea farming. In conclusion, dodder has been extensively distributed on tea farms and is a threat to tea farming in the study area. This study recommends further research to develop effective and sustainable dodder control strategies.*

1. INTRODUCTION

Tea scientifically known as *Camellia sinensis* (L.) Kuntze is a perennial monocultural crop of the family *Theaceae* and genus *Camelia*. It is used to make hot beverages (Gesimba *et al.*, 2005; Chen *et al.*, 2022). It has two varieties; *Camellia sinensis* var. *sinensis* and *Camellia sinensis* var. *assamica* that have produced numerous cultivars and hybrid varieties (Mitra and Khandelwal, 2017).

The tea plant is native to China and grown in 60 countries globally (Bermúdez *et al.*, 2024). China is the leading tea producer globally, followed by India, Kenya, and Sri Lanka respectively (Beringer *et al.*, 2020). According to Voora *et al.*, (2019), the tea industry has supported the livelihoods of over 13 million people globally through employment. Additionally, it has created a source of income for 9 million smallholder farmers. Africa and Asia contribute to about 70% of the global tea production.

Kenya is the world's third largest tea producer after China and India (Tuitoek *et al.*, 2020). Its tea contributes to about 18% of total global production (Sriram, 2022). Small-scale tea farming is practiced in almost 19 counties in Kenya situated in the highlands accounting for 60% of the total Kenyan tea production (Onduru *et al.*, 2012). Additionally, it supports the livelihoods of 0.6 million Kenyans (Kamunya *et al.*, 2019). According to the Kenya National Bureau of Statistics (KNBS) (2024), tea was the second leading Kenyan export after horticulture earning the country Ksh. 187.4 billion in 2023.

In Nandi County, tea is one of the most-grown cash crops (Jalang'o *et al.*, 2023). It covers about 19,920 hectares with an average production of 9 tonnes per hectare, (NCIDP, 2018). Tea farming is practiced in both small and large scale (Tuitoek *et al.*, 2020). The smallholder farmers are managed by the Kenya Tea Development Agency (KTDA). In the county, there are two factories under KTDA; Chebut and Kaptumo (Koech, 2022). Tea is the mainstay in Nandi County supporting the livelihoods of many residents. However, dodder infestation continuously threatens tea production quality and quantity, which may further result in socioeconomic instability.

The dodder plant is an invasive parasitic species belonging to the family *Convolvulaceae* (Morning glory) and genus *Cuscuta* (Yego *et al.*, 2022; Glofcheskie *et al.*, 2023). Dodder species are reported to

be native to the Northern parts of America (Dechassa and Regassa, 2021). They are characterized by yellow, orange, or yellow-green, leafless twining stems. Dodder species produce small, bell-shaped flowers that range from yellow to white (Ngare *et al.*, 2020). Dodder has specialized root structures (haustorium) (Dawson *et al.*, 1994; Saric-Krsmanovic *et al.*, 2019), which penetrate the plant host sucking nutrients.

In Africa, dodder attacks have become increasingly prevalent with insufficient research on dodder despite being a threat to crops of economic importance (Masanga *et al.*, 2021). In Kenya, dodders have high suitability for ravaging tea and coffee (Chepkirui, 2020; Masanga *et al.*, 2021). Once a dodder has infested a tea bush, it leads to the drying of leaves henceforth reducing the chlorophyll content which leads to low tea leaf yield (Yego *et al.*, 2022). In Nandi, there is a lack of detailed information on the extent and knowledge of the impacts of dodder. Understanding the spatial distribution and tea farmers' awareness of dodder will help inform future monitoring and control strategies. To fill the gap, this study was conducted in Nandi County to ascertain the extent of dodder infestation on both small and large-scale tea farms as well as assessing farmers' general knowledge on dodder.

2. MATERIALS AND METHODS

2.1 Study Area

The study was conducted in Nandi County, in the North Rift of Kenya. It lies across the equator between longitudes 34°45' 00" E and 35° 25' 00" E and latitudes 0° 35' 00" N and 0° 06' 00" S covering 2855.8 square kilometers as shown in Figure 1. Nandi has an elevation of 1300m above sea level (NCIDP, 2018). It has diverse climatic conditions, the northern parts of the County receive rainfall ranging from 1300mm to 1600mm suitable for maize, while the southern half experiences 2000mm annually (NCIDP, 2023). The average temperature ranges from 18°C to 22°C. Tea farming is practiced in the Upper Midland and Lower Highland agroecological zones (NCIPD, 2023).

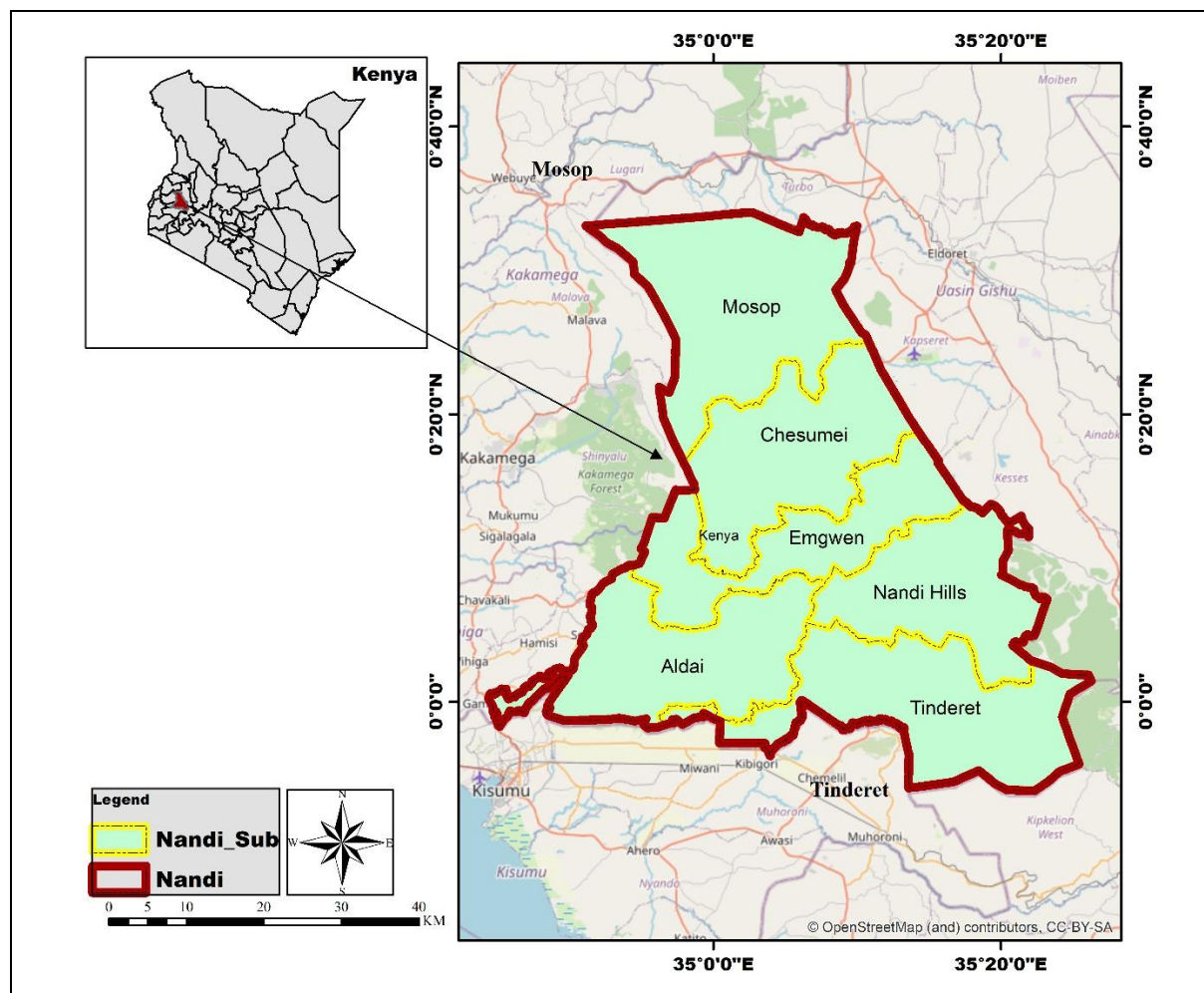


Figure1. Map of the Study area

2.2 Research Design

An exploratory survey design was used to conduct this research. Olawale *et al.*, (2023) describe an exploratory research design used when investigating a new phenomenon, justifying why it was suitable for this study. This design was to provide insights into dodder infestation on tea as it is a new area of study in the context of Nandi County. This study gathered information on the general perceptions of respondents on tea and the location of farms with dodder. Data was collected through the use of a semi-structured questionnaire, and field observations. For dodder locations, coordinates were picked to map the farms with dodder.

2.3 Sample Size

For this study, households registered under KTDA were chosen to represent the small-scale, and multinational tea estates were considered to represent the large-scale tea farms in Nandi.

In small-scale tea farms, a sample size of 392 was obtained by applying the Yamane formula, (1967) to the 19,754 tea-growing households registered under KTDA;

$$n = \frac{N}{(1 + N(e)^2)}$$

N was the total number of tea-growing households, n was the sample size, and e was the margin error taken as 0.05 at a 95% confidence level. Therefore;

$$n = \frac{19,574}{(1 + 19,574(0.05)^2)}$$

$$n = 392.3034$$

The sample size was distributed proportionally to the population of tea farmers delivering their tea to the two KTDA factories in Nandi County. Large-scale tea farms were purposefully selected from multinational tea companies including; Eastern Produce Kenya Limited, Nandi Tea Estates Limited, The Williamson Kenya Limited, and the Nyayo Tea Zones Development Corporations. Of which 6 tea estates were sampled represented in Table 1.

Table1. *Sample frame for the study*

| S/N | KTDA Catchment | Population | Sample size |
|-----|--|---|----------------------------|
| 1. | Chebut | 12,084 | 242 |
| 2. | Kaptumo | 7,490 | 150 |
| | Multinational Tea Companies | Tea Estates | Sampled Tea Estates |
| 3. | Eastern Produce Kenya Limited | Kibabet, Kapsumberiwa, Kipkoimet, Kepchomo, Chemomi, Savani, Sitei, Kaboswa, Kipkeibon, Siret, Kibwari and Kaprachoge | Chemomi and Siret |
| 4. | Williamson Kenya Limited | Tindiret, Kapchorua, and Kaimosi | Kapchorua and Kaimosi |
| 5. | Nandi Tea Estate Limited | Mokon, Kapsiwon, and Taito | Taito |
| 6. | Nyayo Tea Zone Development Corporation | Kipchabo | Kipchabo |

2.4 Data Analysis

To map the extent of dodder infestation coordinates taken from the field were uploaded to ArcMap version 10.8.2. This helped to visualize the spatial distribution of dodder in the study area. Qualitative data from a structured questionnaire was analyzed using Statistical Packages for Social Science SPSS software. The results were presented on a map and descriptive tables.

3. RESULTS AND DISCUSSION

3.1 Demographic Characteristics of the Respondents

The response rate for this study was 354 (90.3%) out of the 392-sample size obtained. It was observed that 77.7% of the respondents were male and 22.3% were female. This implied that males head most

tea households in the study area. One sample T-test indicated a significant difference in gender of the tea-growing households of tea farmers ($N= 354, t = 55.19, df= 353, p= 0.000$) as there were more males than females agreeing with studies by Limo (2013), and Makone *et al.*, (2017).

The literacy levels of the respondents determined by education level in this study indicated that 40.7% had attained tertiary education, 34.2% had reached secondary school, 13.3% were primary school attendees and 11.9% had not gone to school. These results conform to a study by Edwin and Nyambedha, (2017) that most farmers in the County have attained secondary and tertiary education levels.

3.2 Distribution of Dodder in Nandi

99.4% of the respondents knew of dodders but didn't know their names. It was called (Kambet ne yellow) meaning yellow ropes in their local dialect. The results showed that out of 354 respondents, 149 (42%) reported cases of dodder infestation on their tea farms, while 205 (58%) had not handled dodder presence on their tea farms. To classify further, which catchment had high cases of dodder presence on their tea farms, Chebut recorded 78 and Kaptumo 71 accounting for 22% and 20% of the total households. In the multinational tea estates, 3 of the 6 chosen for the study had recorded cases of dodder infestation in their catchments. To map the areas with dodder coordinates taken from the field study were analyzed and presented as shown in Figure 2.

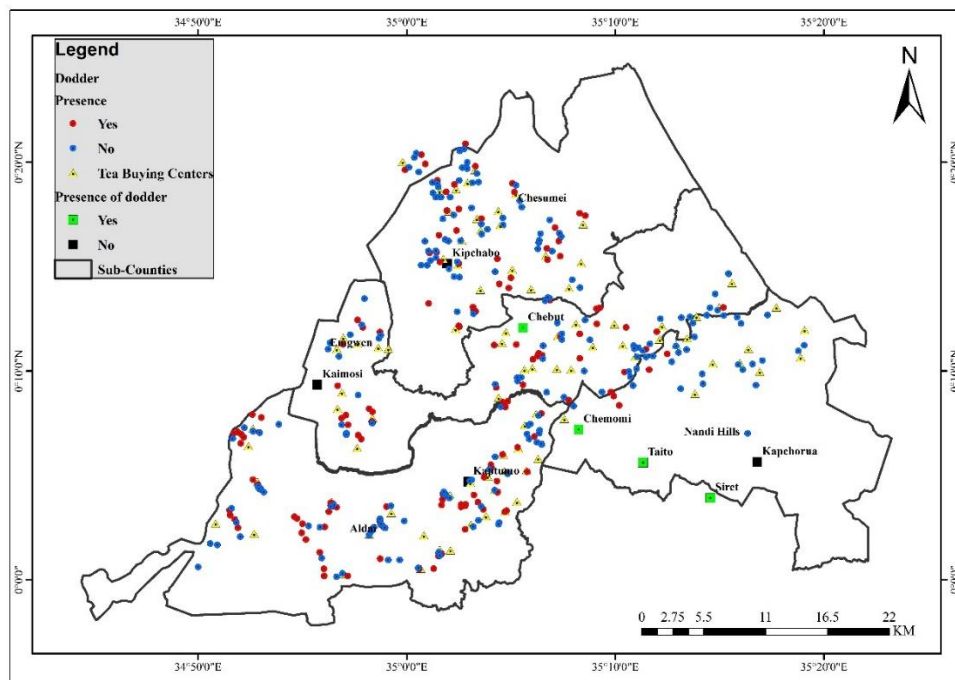


Figure2. Distribution of dodder in the study area

For this study, it was important to note the agents of dodder spread to employ effective control strategies. 74.9% of the respondents recorded that children are the major agents of dodder spread. In most reported cases, school-going children were likely to throw the vines on the tea farms due to the bright yellow colors that attract them. These findings agree with a study by Kagezi *et al.*, (2021) and Kokwon *et al.*, (2022). 45% of the respondents reported that poor handling of infected plants furthers the spread of dodder to new areas. From the study, it was observed that tea farms adjacent to the roads were more likely to be infested by dodder. This observed pattern could be due to children passing by tending to throw the vines on the tea farms near the road. For management strategies, samples of dodder specimens were taken to the National Museums of Kenya for identification. The results revealed two dodder species; *Cuscuta kilimanjari* and *Cuscuta reflexa* that had infested tea farms.

3.3 Respondents' Perceptions of the General Knowledge of Dodder

Tea farmers were asked about their general knowledge of dodder. A 5-point Likert scale was used to record respondents' awareness of dodder. The results were recorded in Table 2. It was noted that 97.7% of the respondents acknowledged that dodder is a threat to tea farming. This observation was supported

by the standard deviation of 0.26, implying few variations in responses on the same. 94.3% of the respondents agreed that KTDA had not given any dodder management guidelines. These findings agreed with the study by Chepkirui (2020) which established, that despite tea crops being the suitable dodder host, KTDA had not reached out to tea farmers to sensitize them on the effects and ways of managing the parasitic plant.

Table2. Respondents' general knowledge of dodder (%)

| | | SD | D | N | A | SA | Total | n | Mean | Std. Dev. |
|----|---------------------------------|------|-----|-----|------|------|-------|-----|------|-----------|
| 1. | Threat to tea farming | 0.3 | 0.0 | 0.9 | 1.1 | 97.7 | 100 | 350 | 4.97 | 0.26 |
| 2. | Medicinal plant | 97.1 | 0.9 | 0.9 | 0.3 | 0.9 | 100 | 349 | 1.07 | 0.45 |
| 3. | Spreads faster after attachment | 0.6 | 0.0 | 0.9 | 8.0 | 89.0 | 100 | 348 | 4.88 | 0.43 |
| 4. | No guidelines from KTDA | 0.6 | 0.0 | 0.9 | 4.3 | 94.3 | 100 | 348 | 4.92 | 1.40 |
| 5. | Chemicals are expensive to buy | 0.6 | 0.0 | 4.0 | 13.8 | 81.7 | 100 | 349 | 4.77 | 0.54 |

SD is Strongly Disagree, D; Disagree, N; Neutral, A; Agree, SA; Strongly Agree, and n is the number of observations.

4. CONCLUSION

The study sought to assess the extent of dodder infestation on tea in Nandi County. It was concluded that dodder had significantly infested most tea farms in the study area. The dominating dodder species were; *Cuscuta kilimanjari* and *Cuscuta campestris*. The respondents in the study area were aware of dodder, pathways of spread, and its effects on tea farming. Therefore, the study recommends that KTDA should partner with other research institutions such as; the Tea Research Foundation and Kenya Agricultural and Livestock Research Organization (KALRO) to train and support smallholder farmers on Integrated Pest Management on dodder management.

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