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Original Research Article

Effect of application of NPK fertilizer and bending of the mother plants on the suckering ability of selected Coffee Wilt Disease resistant Robusta coffee (*Coffea canephora*) varieties in Uganda

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Abstract: In response to the outbreak of Coffee Wilt Disease (CWD) in the 1990's and 2000's which killed nearly half of the Robusta coffee in Uganda, causing losses of about US$100 million, the National Agricultural Research Organization (NARO) released 10 CWD-r resistant varieties or Kituza Robusta (KR's). These varieties are being mass produced by cloning though, KR1, KR3 and KR4 have been reported to have poor suckering ability. An on-station study was therefore conducted to determine the effect of NPK fertilizer and bending angle of mother plants on suckering ability of these varieties. A split plot design with three replications was used, with fertilizer levels (0, 50, 75 and 100 g) as main plot and bending angle (vertical, 0°, inclined, 45° and horizontal, 90°) as sub plot. Number of suckers, nodes, leaves and primary branches was established after 180 days. Number of suckers varied significantly ($p \leq 0.05$) across variety, bending angle and fertilizer levels, with the highest being recorded on KR4 (52.1), horizontally-bent plants (68.8) and mother bushes treated with 100 g of NPK (55.1). In addition, a significant ($p \leq 0.05$) interaction was also observed between the bending angle and fertilizer for all the three coffee varieties. Horizontally-bent coffee registered the highest number of suckers when applied with 100 g of NPK for KR1 (74.3) and KR3 (94.0) whereas, 75 g of NPK for KR4 (111.0). Our findings provide a guide to coffee nursery operators on best-bet good agronomic practices (GAP's) for enhancing suckering of these CWD-r Robusta coffee varieties.

Keywords: CWD-r, Good-Agronomic-Practices, Growth-Parameters, Horizontally-Bent, KR's, Mother Plants, Nursery-Operators, Suckers.

INTRODUCTION

Coffee (*Coffea* spp.) is a high-value commercial crop worldwide, the second most traded global commodity after oil (Slavova & Georgieva, 2019), and is a major income source for millions of smallholder livelihoods in developing nations (Voora *et al.*, 2019). Uganda is the world's 7th largest exporter of coffee, and Africa's 2nd largest exporter, after Ethiopia (Davis *et al.*, 2023). In Uganda, coffee plays a major role in providing foreign exchange (NCP, 2013; NPA, 2024). For example, coffee exports for 12 months (May 2024 to April 2025) totaled 7.17 million 60-kg bags worth US$1.97 billion (MAAIF, 2025). Over 1.7 million smallholders grow the crop on an estimated 583,000 hectares of land (UCDA, 2020).

Two important types of coffee are grown in Uganda, with Robusta coffee constituting about 80% whereas Arabica takes the remaining 20% (UCDA, 2019b). Despite the importance of Robusta coffee to the smallholder farmers and the national economy, its yield remains very low at an average 0.55 kg ha^{-1} of green coffee beans (Bakema & Schluter, 2019) compared to 3.5 kg ha^{-1} reported in well-managed large Robusta coffee plantations (Van der Vossen, 2005). This is due to a number of biotic and abiotic constraints, among other factors (Wang *et al.*, 2015; Nakyagaba *et al.*, 2024;

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Olango *et al*., 2024; Kyalo *et al*., 2025). Coffee Wilt Disease (CWD), caused by the fungus *Fusarium xylarioides* which was first reported in 1993 in the western district of Bundibugyo has been the most important biotic constraint (Peck & Boa, 2024). This disease killed nearly half of the Robusta coffee in Uganda in the 1990's and early 2000's, leading to a loss of about US$100 million (Musoli *et al*., 2003)

In response, the National Coffee Research Institute (NaCORI) of the National Agricultural Research Organization (NARO), developed 10 Coffee Wilt Disease resistant (CWD-r) Robusta coffee varieties or Kituza Robusta (KR1-KR10) for commercialization (Musoli *et al*., 2008, 2017). These varieties are available for multiplication but the quantities accessible are far below the 68 million seedlings required per year to replace the existing trees which are either too old or not CWD-r (or both), for gap filling and expansion of coffee gardens (Bakema & Schluter, 2019). However, the primary obstacle in cultivating these varieties is acquiring high-quality seed for propagation, since this method, although it is relatively quick and prolific, it generates new plants with genetic traits that vary from those of the parent plant because of outcrossing behavior (Cubry *et al.,* 2013; Moraes *et al*., 2018; Spinelli *et al*., 2018). Uncontrolled cross-pollination produces seeds with differing genetic traits from the initial parent plant (Akpertey *et al.,* 2022). Robusta coffee plants should therefore be propagated using vegetative methods such as shoot grafting or cuttings (Angelo *et al*., 2018; Espindula *et al*., 2022). In commercial production of plantlets, the stem cuttings are taken from coffee plants that are grown in a "mother" or "clonal garden" (Fonseca *et al.,* 2019; Kolln *et al.,* 2022). Another reason for promoting the use of clonal cuttings for the CWD-r Robusta coffee varieties is the Government policy of phasing out the use of reproductively generated Robusta coffee elite seedlings in Uganda (UCDA, 2020).

Nevertheless, the number of suckers produced by a Robusta coffee mother plant is determined by pre-harvest agronomic practices applied in the mother garden and these include: the variety used, bending or training of the plant as well as soil fertility and moisture management, among others (Chemura, 2014; Megersa, 2022). Genetic variability among the genotypes of *Coffea canephora* has been reported to affect the formation of orthotropic branches, which is a desirable attribute due to the necessity of multiplication by rooting cuttings and renewal of the coffee canopy (Dalcomo *et al*., 2015, 2017; Rodrigues *et al*., 2017). The genetic makeup has been reported to influence the number of suckers produced by Robusta coffee trees (Martins *et al*., 2020; Carvalh *et al*., 2022), with the different varieties having varying suckering habits and production rates (Dalcomo *et al*., 2015, 2017; Rodrigues *et al*., 2017). However, this phenomenon is yet to be fully studied and documented in case of the newly-released CWD-r Robusta coffee varieties.

On the other hand, bending or training coffee shoots breaks the apical dominance and encourages dormant buds in the leaf axils to produce suckers at the base (Tjosvold, 2001; Ito *et al*., 2004; Espindula *et al*., 2020; Teixeira *et al*., 2020). Several authors have reported that bending of shoots at different angles influences the growth of vegetative parameters (Han *et al*., 2007; Zhang *et al*., 2017; Khandaker *et al*., 2020; Atal & Mitra, 2023), though, the best-bet bending angle for maximum production of suckers is yet to be established for the CWD-r Robusta coffee varieties. In addition, the nutritional management of the coffee mother garden influences the production of suckers as well as the physiological quality of the resultant cuttings (Hassan *et al*., 2015; Kolln *et al*., 2022; Megersa, 2022). Coffee mother garden production therefore requires fertile soil with higher levels of nitrogen for massive vegetative growth combined with lower phosphorus and potassium contents for normal tree shoot growth and development (UCDA, 2019b). However, there is limited information on the best-bet NPK application rate for maximizing production of suckers of the mother plants of the CWD-r Robusta coffee varieties.

Basing on this backdrop, we therefore conducted an on-station study to determine the effect of application of NPK fertilizer and bending angle of the mother plant on the suckering ability of three selected CWD-r Robusta coffee varieties. Specifically, we hypothesized that: i) suckering ability depends on the CWD-r Robusta coffee variety in question, ii) application of nitrogen-based fertilizers increases the suckering ability of the CWD-r Robusta coffee mother plants, iii) a bent coffee mother plant produces more suckers, and, iv) the interaction between application of NPK fertilizers and the bending angle of the coffee mother plant increases the suckering ability of the CWD-r Robusta coffee varieties.

MATERIALS AND METHODS

Study Area

The study was conducted at the National Coffee Research Institute (NaCORI) station which is located within the Lake Victoria Crescent Agroecological zone in Kituza village, Ntenjeru sub-county, Mukono district, central Uganda (Fig. 1). NaCORI is located about 37 km east of Kampala (Latitude: 0.25718; Longitude: 32.79036) and at an altitude of 1,205 meters above sea level (a.s.l). The area has a tropical climate with a bi-modal rainfall pattern, the mean annual rainfall is 1,100 mm distributed over 106 rain days, with peaks in March-May and September–November and the temperatures ranges between 16^0C and 28^0C throughout the year (Kobusinge *et al*., 2023). The topography of the area consists of sloping land with many undulations dominated by sandy loam soil and the vegetation cover is of the forest/savannah which are characterized by patches of dense forest (Mukono District, 2016).

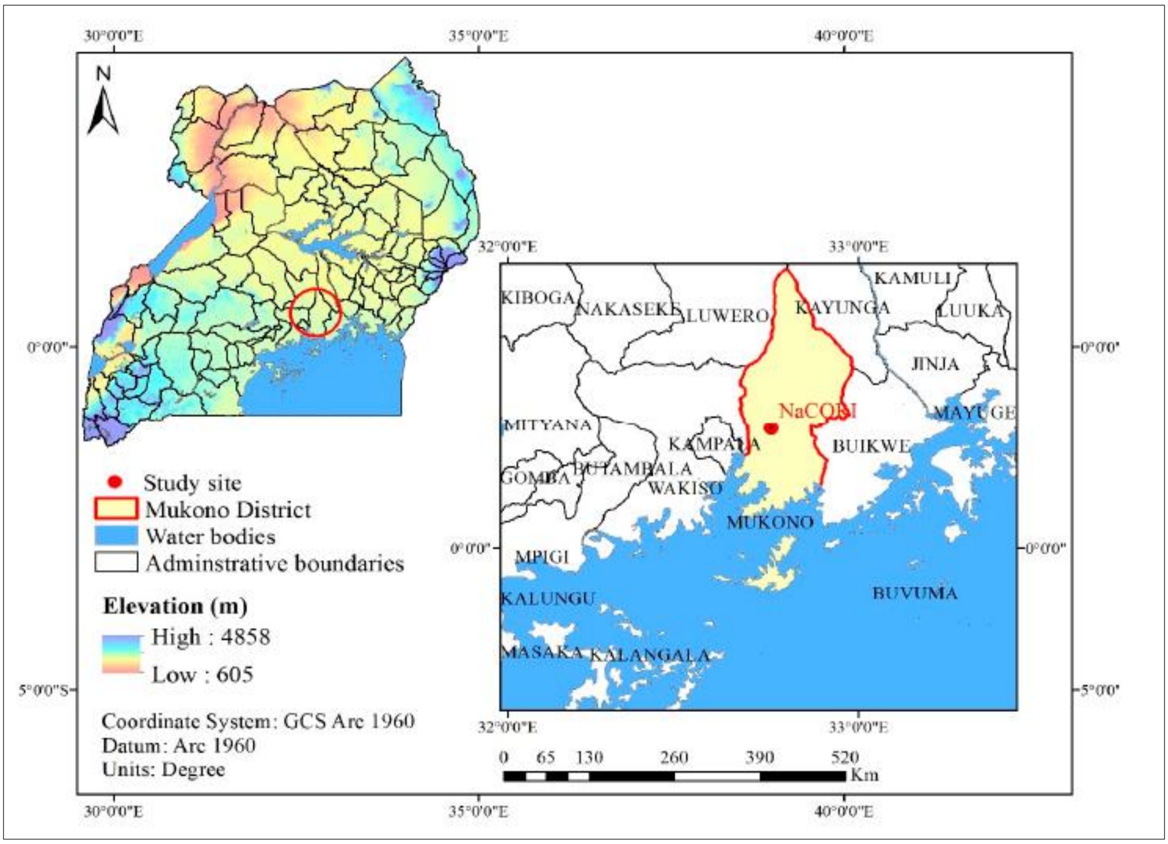

Figure 1: Location of the study area in Mukono district, central Uganda (Source: Kobusinge *et al*., 2023)

Experimental Design

Three CWD-r Robusta coffee varieties (KR1, KR3 and KR4) were selected on the basis of their suboptimal suckering abilities and each of them was arranged separately in split-plots in a completely randomized block design (RCBD) with three replications. The main plot factor was the NPK fertilizer application rates with four treatments namely: 0, 50, 75 and 100 g NPK whereas, the sub-plot was the bending angle of the mother plant, with three treatments namely: vertical, 0^0 (Fig. 2), inclined, 45^0 (Fig. 3), and horizontal, 90^0 (Fig. 4). The fertilizer treatments were applied by placement method in a shallow ring at a distance of 30 cm around the base of each coffee mother plant. The detailed description of the treatments is shown in table 1 below. For each variety, the vertically-bent coffee (recommended) and applied with 0 g of NPK acted as the control and the treatments were administered to a plot of three (3) coffee mother plants.

Figure 2: Vertically-bent (recommended) Coffee Wilt Disease resistant (CWD-r) Robusta coffee suckers (Source: Epedu, 2025)

Figure 3: Inclined-bent Coffee Wilt Disease resistant (CWD-r) Robusta coffee suckers (Source: Epedu, 2025)

Figure 4: Horizontally trained Coffee Wilt Disease resistant (CWD-r) Robusta coffee suckers (Source: Epedu, 2025)

Table 1: Description of treatments used for determining the effect of variety, bending and NPK fertilizer application rates on the suckering ability of three selected Coffee Wilt Disease resistant (CWD-r) Robusta coffee varieties

KR1	KR3	KR4
T_{11}=Vertical + 0gNPK	T_{31}=Vertical + 0gNPK	T_{41}=Vertical + 0gNPK
T_{12}=Vertical + 50gNPK	T_{32}=Vertical + 50gNPK	T_{42}=Vertical + 50gNPK
T_{13}=Vertical + 75gNPK	T_{33}=Vertical + 75gNPK	T_{43}=Vertical + 75gNPK
T_{14}=Vertical + 100gNPK	T_{34}=Vertical + 100gNPK	T_{44}=Vertical + 100gNPK
T_{15}=Inclined + 0gNPK	T_{35}=Inclined + 0gNPK	T_{45}=Inclined + 0gNPK
T_{16}=Inclined + 50gNPK	T_{36}=Inclined + 50gNPK	T_{46}=Inclined + 50gNPK
T_{17}=Inclined + 75gNPK	T_{37}=Inclined + 75gNPK	T_{47}=Inclined + 75gNPK
T_{18}=Inclined + 100gNPK	T_{38}=Inclined + 100gNPK	T_{48}=Inclined + 100gNPK
T_{19}=Horizontal + 0gNPK	T_{39}=Horizontal + 0gNPK	T_{49}=Horizontal + 0gNPK
T_{110}=Horizontal + 50gNPK	T_{310}=Horizontal + 50gNPK	T_{410}=Horizontal + 50gNPK
T_{111}=Horizontal + 75gNPK	T_{311}=Horizontal + 75gNPK	T_{411}=Horizontal + 75gNPK
T_{112}=Horizontal + 100gNPK	T_{312}=Horizontal + 100gNPK	T_{412}=Horizontal + 100gNPK

Data Collection

Data on suckering ability were collected 180 days after initial application of the treatments. The number of suckers per mother plant and counting the number of leaves, nodes, and primary branches on the suckers were counted and recorded.

Data Analysis

Data were analyzed using Analysis of Variance (ANOVA) and significant means separated by Scheffe test at a 5% significance level. Additionally, correlation and regression tests were performed to explore the relationships between research variables. All analyses were performed using R statistical software (Version R-4.4.2).

RESULTS AND DISCUSSION

Effects of Variety on The Suckering Ability of Mother Plants of the Three Selected CWD-r Robusta Varieties

Table 2 below shows that the number of suckers and leaves produced were significantly ($P \geq 0.5$) different across the three selected CWD-r Robusta coffee varieties while the number of nodes and primary branches was not significantly ($p \geq 0.05$) different. However, variety KR4 performed best for all the vegetative parameters, with the highest number of suckers (52.1), nodes (93.8), leaves (406.6) and primary branches (47.7). This finding agrees with earlier research studies by Dalcomo *et al*., (2015, 2017) and Rodrigues *et al*., (2017) who also observed variations in the agronomic performance of the orthotropic branches across different genotypes of *Coffea canephora* (Pierre ex A. Froehner).

Robusta coffee has a significant degree of genetic and phenotypic heterogeneity, which may contribute to the variation in suckering capacity and ability among the different varieties (Kiwuka *et al*., 2021; Akpertey *et al*., 2022; Bezerra *et al*., 2023). However, it should be noted that in addition to its genetic makeup, vegetative growth rate of Robusta coffee is also influenced by other factors such as: - environmental conditions (temperature, light and moisture), shade intensity and soil fertility, among others (Damatta & Ramalho, 2006; Damatta *et al*., 2007; Alves & Mazzafera, 2008; Venancio *et al*., 2019; Dinh *et al*., 2022).

Table 2: Effect of variety on the suckering ability of selected Coffee Wilt Disease resistant (CWD-r) Robusta coffee varieties

Variety	Mean±Standard deviation			
	Suckers	Nodes	Leaves	Primary branches
KR1	33.3±22.4^{b}	69.2±43.9^{a}	226.4±156.1^{b}	38.1±22.2^{a}
KR3	39.8±29.1^{ab}	83.1±58.8^{a}	376.2±203.8^{a}	38.2±26.0^{a}
KR4	52.1±41.3^{a}	93.8±71.0^{a}	406.6±261.5^{a}	47.7±35.0^{a}
CV	76.49	71.83	62.89	68.32
F value	3.21	1.57	7.48	1.36
P value	0.044	0.2125	0.0009	0.295

Same letters in superscript indicate no significant difference at p≥0.05 using the Scheffe test

Effect of NPK Fertilizer Rates on the Suckering Ability of the Mother Plants of the Three Selected CWD-R Robusta Varieties

Regression analysis results of our study also showed that NPK fertilizer levels applied to CWD-r Robusta coffee mother bush was positively and significantly ($p \leq 0.05$) correlated with the number of suckers, nodes, and leaves of the CWD-r Robusta coffee varietals (Fig. 5). But also, the number of primary branches produced was slightly dependent ($p=0.053$) on the level of NPK applied. This implies that increasing the level of NPK applied to coffee mother bush, enhances the production of suckers, nodes and leaves of the three selected CWD-r Robusta coffee varieties.

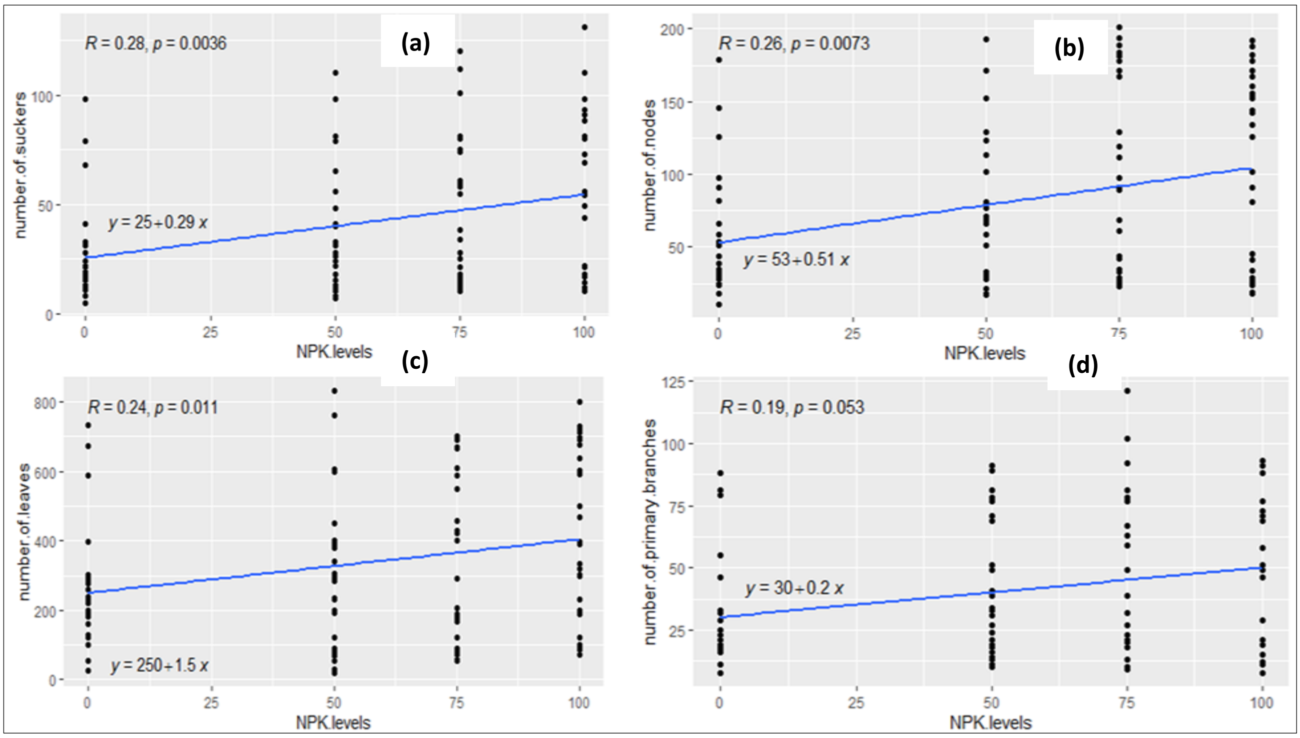

Figure 5: Relationship between NPK fertilizer levels and the number of suckers (a), nodes (b), leaves (c) and primary branches (d) produced by Coffee Wilt Disease resistant (CWD-r) Robusta coffee

This finding is also supported by the Analysis of Variance (ANOVA) results in table 3 below which showed that the number of suckers, nodes, and leaves produced by the CWD-r Robusta coffee varieties varied significantly ($p \leq 0.05$) across the NPK rates. However, there was no significant ($p=0.0567$) difference in the number of primary branches produced, across the NPK rates. Robusta coffee applied with 100 g of NPK performed best with the highest number of suckers (55.1), nodes (103.7), leaves (420.6), and, primary branches (48.8). Similar studies have also reported that application of nitrogen-based fertilizers enhances the performance of coffee growth parameters including the orthotropic and plagiotropic branches, nodes and leaves (Dubberstein *et al*., 2017; Busato *et al*., 2022; Kolln *et al*., 2022, 2024). This has also been reported in other tree species such as apples, *Malus domestica* (Mészáros *et al*., 2023), cherry leaves, *Prunus cerasus* L. (Rutkowski & Łysiak, 2023) and moringa, *Moringa oleifera* Lam (Adamu *et al*., 2017), among others.

Exogenous application of nitrogen-based fertilizers stimulates the translocation of soil N to shoots (Sarker *et al*., 2017) where it plays an important role as a basic element of protein, nucleic acids, chlorophyll and growth hormones that are essential in periods of rapid growth (Fathi, 2022). Application of N has also been reported to increase the transport of gibberellins from roots to shoots (Mostafa, 2019; Wilson, 2000), this breaks the apical dominance and promotes shoot branching in perennial woody plants such as coffee (Elfving *et al*., 2011).

Table 3: Effect of varying NPK fertilizer levels on the suckering ability of selected Coffee Wilt Disease resistant (CWD-r) Robusta coffee varieties

NPK level	Mean±Standard deviation			
	Suckers	Nodes	Leaves	Primary braches
0	27.1±21.6^{b}	54.7±41.1^{b}	264.4±170.3^{b}	29.9±21.6^{a}
50	35.6±28.6^{ab}	73.7±52.7^{ab}	299.3±218.1^{ab}	39.6±26.5^{a}
75	49.1±35.9^{a}	96.0±65.1^{a}	361.4±242.4^{ab}	47.0±32.6^{a}
100	55.1±36.0^{a}	103.7±64.8^{a}	420.6±237.5^{a}	48.8±29.0^{a}
CV	74.48	69.22	65.08	67.08
F value	4.50	4.15	2.68	2.59
P value	0.002	0.0081	0.0508	0.0567

Same letters in superscript indicate no significant difference at p≥0.05 using the Scheffe test

Effect of Bending on the Suckering Ability of Mother Bushes of the Three Selected CWD-r Robusta Varieties

Regression analysis results of our study showed that the bending angle of the mother plant was positively and significantly ($p \leq 0.05$) related to the number of suckers, nodes, leaves and primary branches produced (Fig. 6). This implies that bending the mother plant enhances the production of suckers, nodes, leaves and primary branches of the three selected CWD-r varieties.

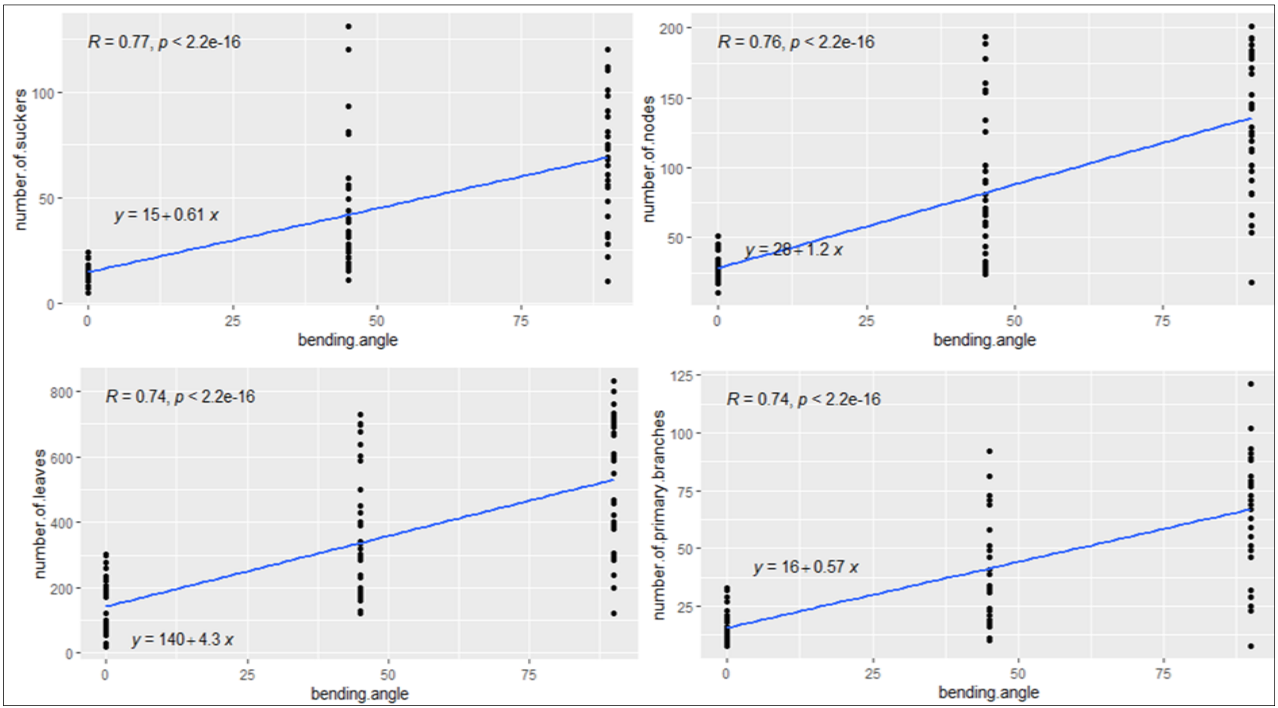

Figure 6: Relationship between bending angle of the suckers and the number of suckers (a), nodes (b), leaves (c) and primary branches (d) produced by Coffee Wilt Disease resistant (CWD-r) Robusta coffee varieties

This fact is supported by the ANOVA results which shows that the number of suckers, nodes, leaves, and primary branches varied significantly ($p<0.0001$) across the bending angles of the suckers in mother plants

(Table 4). Coffee that was bent horizontally performed best, having the highest number of suckers (68.8), nodes (137.1), leaves (523.1) and, primary branches (69.0). This finding agrees with other research studies which have reported that horizontal bending of the main stem promotes the induction of shoots in coffee (Pohlan & Janssens, 2015; Schmidt *et al*., 2015; Rodrigues *et al*., 2017; Espindula *et al*., 2020) as well as other plant species (e.g. Reubens *et al*., 2009; Zhang *et al*., 2013; Sarkar *et al*., 2017; Khandaker *et al*., 2020; Tamang *et al*., 2021). All in all, orthotropic stems of Robusta coffee mother plants are supposed to be bent in order to promote the emission of new sprouts known as suckers from which harvesting of cuttings is done (Schmidt *et al*., 2015; UCDA, 2019a,b).

The predominance of horizontal bending in terms of vegetative growth of Robusta coffee can be discussed in the light of bending techniques aiding to the breaking of the apical dominance, likely because the flow of the auxin hormone is hampered in the bent branch and stimulates the outgrowth of lateral shoots (Devy *et al.,* 2023; Natalia *et al.,* 2025). These modifications change the concentration of this hormone near the axillary buds and interrupt the synthesis of strigolactone, which is the hormone responsible for activating the gene that suppresses the growth of axillary buds and inhibits local biosynthesis of cytokinin (Ferguson & Beveridge, 2009; Tan *et al.*, 2019). The lack of regulation by strigolactone and increased levels of cytokinins close to axillary buds induce cells to resume cell division and, thus, the growth of branches (Espindula *et al*., 2020; Zha *et al*., 2022). Bending also opens up the canopy and creates gaps between the coffee branches for light penetration and air circulation inside the canopy of the coffee mother plants (Cahyono *et al*., 2023), increasing leaf photosynthesis through changes in sunlight exposure on the leaves (Desrochers *et al*., 2015; Dufour *et al*., 2019). It has also been suggested that bending enhances the sink strength and source capacity by facilitating more light penetration inside the plant canopy and maintaining higher levels of endogenous cytokinin (Ito *et al*., 1999), which in turn might have accelerated the developmental process of shoots (Werner *et al*., 2001). Furthermore, horizontal bending has been reported to result in more synthesis, transport, and accumulation of photo-assimilates around the bent points of the mother plant, thus, supporting the sprouting of suckers (Zhang *et al*., 2020). Increased production in bent coffee plants could also be explained by the high density of production points formed along the lateral stem system (Ohkawa & Suematsu, 1999; Espindula *et al*., 2020).

Table 4: Effect of bending angle on the suckering ability of selected Coffee Wilt Disease resistant (CWD-r) Robusta coffee varieties

Bending angle	Mean±Standard deviation			
	Suckers	Nodes	Leaves	Primary branches
Horizontal	68.8±28.6^{a}	137.1±46.2^{a}	523.1±186.1^{a}	69.0±23.8^{a}
Inclined	42.1±29.6^{b}	79.6±50.6^{b}	351.0±184.1^{b}	37.2±21.6^{b}
Vertical	14.3±4.8^{c}	29.5±9.0^{c}	135.1±84.6^{c}	17.8±6.8^{c}
CV	57.34	48.61	47.21	45.87
F value	46.62	65.59	35.94	65.99
P value	<.0001	<.0001	<.0001	<.0001

Same letters in superscript indicate no significant difference at p≥0.05 using the Scheffe test

Interactive Effects of Bending Angle and NPK Fertilizer Levels on the Suckering Ability of Three Selected Coffee Wilt Disease Resistant (CWD-r) Robusta Coffee Varieties

Table 5 below shows that there was a significant (p≤0.05) interaction between the bending angle and the NPK fertilizer for all the three selected Coffee Wilt Disease resistant (CWD-r) Robusta coffee varieties.

Table 5: Interactive effects of the bending angle and NPK fertilizer on the number of suckers produced by the mother bushes of selected Coffee Wilt Disease resistant (CWD-r) Robusta coffee varieties

Source of variation	DF	ANOVA SS	Mean square	F value	P value
KR1					
Bending angle	2	11661.72222	5830.86111	201.26	<.0001
NPK fertilizer	3	3624.75000	1208.25000	41.70	<.0001
Bending angle*NPK fertilizer	6	1649.83333	274.97222	9.49	<.0001
KR3					
Bending angle	2	14121.50000	7060.75000	48.62	<.0001
NPK fertilizer	3	8275.88889	2758.62963	19.00	<.0001
Bending angle*NPK fertilizer	6	3818.27778	636.37963	4.38	0.0040
KR4					
Bending angle	2	30362.16667	15181.08333	24.94	<.0001
NPK fertilizer	3	4042.30556	1347.43519	2.21	0.1126
Bending angle*NPK fertilizer	6	10676.27778	1779.37963	2.92	0.0276

In addition, the number of suckers produced varied significantly (p<0.00001) across the bending angles of suckers of Coffee Wilt Disease resistant (CWD-r) Robusta coffee KR1 variety (Table 6). The highest number of suckers for KR1 (74.3) and KR3 (94.0) was recorded on coffee bent horizontally and applied with 100 g of NPK whereas, for KR4, the highest number of suckers (111.0) was observed on coffee bent horizontally but applied with 75 g of NPK. Our finding is in agreement with studies by Rohani *et al*. (2024) which reported that bending coffee and applying it with a combination of chicken manure and NPK fertilizers enhanced various coffee parameters, resulting in an increased stem diameter, new shoot length, and chlorophyll content. Similarly, Devy *et al*., (2023) reported that bending branches of citrus and applying fertilizers on them enhanced vegetative growth which resulted into increased flowering and fruiting. Contrary, Azizu *et al*., 2016) and Natalia *et al*. (2025) observed that combining bending and fertilizer did not result into significant vegetative growth of Borneo Prima tangerine guava plants.

Table 6: Effects of bending angles and nitrogen levels on number of suckers produced by the mother bushes of the three selected Coffee Wilt Disease resistant (CWD-r) Robusta coffee varieties

Treatment	**Mean±Standard deviation**		
	KR1	KR3	KR4
Horizontal_0gNPK	27.0±4.6^{d}	34.0±6.6^{de}	81.7±15.2^{ab}
horizontal_50gNPK	56.3±8.5^{bc}	51.7±25.7^{cd}	95.7±15.6^{ab}
HoriHontal_75gNPK	64.3±8.5^{b}	70.3±13.6^{bc}	111.0±9.5^{a}
Horizontal_100gNPK	74.3±6.1^{a}	94.0±14.7^{a}	65.3±48.2^{b}
Inclined_0gNPK	18.0±3.0^{e}	17.7±3.1^{ef}	19.3±8.5^{c}
Inclined_50gNPK	34.7±4.7^{d}	27.7±3.5^{ef}	22.0±4.0^{c}
Inclined_75gNPK	30.3±6.8^{d}	49.3±13.4^{d}	71.7±53.0^{ab}
Inclined_100gNPK	49.0±5.0^{c}	76.3±19.4^{ab}	89.0±38.3^{ab}
Vertical_0gNPK	8.7±4.0^{f}	16.0±4.6^{ef}	22.0±1.7^{c}
Vertical_50gNPK	9.7±2.5^{f}	11.0±3.6^{f}	12.0±3.6^{c}
Vertical_75gNPK	13.0±2.6^{ef}	13.3±1.5^{f}	18.3±2.5^{c}
Vertical_100gNPK	14.3±3.5^{ef}	16.7±4.5^{ef}	17.0±5.6^{c}
F Value	53.1	16.41	6.733
CV	16.2	30.3	47.4
P value	<0.00001	<0.00001	<0.00001

Same letters in superscript indicate no significant difference at p≥0.05 using the Scheffe test

CONCLUSIONS

We observed that the number of suckers produced by the CWD-r Robusta coffee mother plants varied significantly across the variety, bending angle of the mother plant and application rate of NPK fertilizer. There was also a significant interaction between the NPK fertilizer level and the bending angle of the mother plant. The highest number of suckers was recorded on horizontally-bent coffee, applied with 100 g of NPK for KR1 (74.3) and KR3 (94.0), and, that applied with 75 g of NPK for KR4 (111.0). This study provided valuable practical insights for guiding nursery operators on the best-bet good agronomic practices (GAP's) for enhancing suckering of these three selected CWD-r Robusta coffee varieties. However, further research studies should be conducted on other CWD-r Robusta coffee varieties such as KR8 which have challenges with suckering.

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