ISSN No:-2456-2165

Non True Seed Production Practices and Certification Requirements: A Review

Fungameza Bahati C.[1,*] Richard Madege[1], Yasinta Nzogela[1]
[1]Department of Crop science and Horticulture, Sokoine University of Agriculture Morogoro Tanzania

Abstract:- An effective seed system for non-true seed crops in developing countries are essential in safeguarding supply of planting material to local farmers. Continuing disregard of the distinct biological characteristics of non true seed crop by regulatory body, limit farmers to access high-quality planting material thus increasing the risk of pest and disease transmission. This paper is designed to presents methodologies used in certification procedures of non-true seed crops and the smart mango grafting practices that implies development of quality and certifiable planting materials. The main contribution of this study is to showcase the smart grafting practices that would help the regulatory bodies in the country to establish and enforce the certification standard of non-true seed crops specifically Mango, to guarantee the availability of quality planting material to farmers as well as making a fully control of non-true seed business just like the true seed crop business is.

***Keywords**:- Grafting, Non-true seed, Certification standard, Planting materials, propagules.*

I. INTRODUCTION

A seed is described as a flowering plant which is a unit of reproduction and can eventually develop into another such plant. It is there to ensure the continuity of plant reproduction in plants that produce them. In most of the time, seed exist in a dry form as a mechanism to make it stay dormant for long perioduntil when the necessary condition for germination is supplied.But during that period, it remains viable and can only lead to new plants through germination process. The necessary seed germination condition requires the presence of three main factors i.e. water, oxygen, and warmth (Rajjou et al., 2012).

Non true seed on the other side results to vegetative propagation crops. Un like true seed, nontrue seed ensures continuity of plant through propagation that employ use of plantparts like leaves, roots, and stem (Natural propagation). Artificial propagation is carried out either by using cuttings, grafting, layering or tissue culture. Vegetatively propagated crops have significant contribution to food security and the economy of different countries worldwide (Abdoulaye, 2019). Mango is a perennial fruiting tree crop that is mostly propagated by artificial propagation, largely employing use of grafting methods. The economic importance of Mangois both of nutritional and economical values, fruit elegance, exotic, and flavour appeal. All theseare the factors that make it one of the most widely cultivated tropical fruits in the world with its demand being as high as 43,3 x 10^6 tons in 2013 (FAO, 2013). This demand is huge, and it thus necessitate a closer look on the certification of mango seedlings to ensure a constant flow of these seedling to farmers while ensuring its quality for a sustainable mangoproduction. In Tanzania and many other sub-Saharan African countries, any true seed certification requires that a particular seed variety should be of a notified kind, and it should be in the production chain and its pedigree is traceable. On the other side, field standard should include the selection of site, isolation requirements, spacing, planting ratio, border rows etc.For nontrue seed crops like mango many of the sub-Saharan African countries including Tanzania have not established the certification standard for such crops. Even to some other countries where the certification standard is in practices, the implementation of the standard is not as effective as that of true seed crops. Forexaple, In Indonesia the demand for certified mango seedling is huge but low rate of certified seedling used and Limited availability of superior certified mango seedlingsaffects seedling flow to farmersand hence its productivity (Puspitasari, 2020). An effective seed system for true and nontrue seed crops is vital for sustainable production of not only Mango but also for all other seed and nontrue seed crops. (McGuire et al., 2016). In most African developing countries like Tanzania, more effort on strengthening seed system has been put on formal (regulated) seed system and the focus being on true seed crops, leaving the non-true seed crop stranding and therefore making access to quality planting material (seedlings) unfeasible. (Westengen et al., 2014).This is to mean that many nontrue seed crops or vegetative propagated crops in developing countries are not under regulatory body control in the sense that farmers are producing their own seedlings locally and trade them locally (Abizaid et al., 2016). However, the two system (formal and informal seed system can be integrated and treated or controlled by the same seed regulatory body within a country and this should be noted as an important area to concentrates by the key actors (farmers, policy makers, seed business and entrepreneur). For Mango now, the opportunity present on this gap is to develop a certification smart grafting procedure or practices that will ensure coming out with a quality mango seedling and then be certified by the certification body to make a good control of the business. This way will ensure a coordination between informal seed system actors i.e. farmers, local seed producers, rural entrepreneurs, and traders and formal/controlled system actors i.e., research, extension, and regulatory agencies and from private firms making the system more effective and safer to system consumers.

In Tanzania millions of seedlings are currently being traded as seeds whose seed systems is not controlled by government seed certification urgent, TOSCI. The quality of these seeds and therefore assurance of its quality for field establishment remains a nightmare of every farmer benefiting from such seed system. Therefore, to bring the

ISSN No:-2456-2165

farmers into assurance, TOSCI is coming up with certification standards for different crops including mango seedlings. This means the seedling commercial producers must reorient their way of doing things towards meeting the minimum certification standards which might be different from their conventional methods. That is changing from conventional to certification smart practices which unfortunately have not been developed and it might make attaining to a certified Mango seedlings difficult.

II. EVALUATION OF CURRENT PRACTICES ON MANGO PROPAGULES PRODUCTION

As far as non-true seed crop is concern**, (**Marcel et al., 2021) conducted a study on Policy options for advancing seed systems for vegetatively propagated crops in Vietnam. In their work they evaluated what type of regulatory framework that is appropriate for improving farmers' access to quality vegetative propagatedcrops (Cassava and Potato)planting material and what are the costs, benefits, risks, and unintended consequences are of alternative regulations in Vietnam. The methodology used was key informant interviews, and focus-group discussions.Findings indicate that despite a regulatory regime that imposes strict rules on the production and trade of planting material for Vvegetative Ppropagation crops (VPC), the market is largely unregulated because of weak enforcement capacity. Instead, producers and traders of VPC planting material signal quality to farmers through trust, reputation, and long-term relationships. Though effective at a localized scale, these informal systems are unlikely to accommodate expansion of the cassava and potato sectors and unlikely to prove effective in managing increases in pest and disease pressures that result from crossborder trade or climate change.

Apart from (Marcelet al., 2021); (Yigzaw et al., 2014) conducted a survey with the focus on Mango Production Knowledge and Technological Gaps of Smallholder Farmers in Amhara Region, Ethiopia. A semi-structured questioner was employed for data collection where among many other data, data on seedling sources, and overall mango production constraints were collected both through interview and field observation.The result especially on seedling sources indicated that 72.9%, 2.9%, 1.4%, and 22.9% of the total respondent obtained mango seedlings from government nurseries, private nurseries, their own nursery, and from different sources, respectively. This means that government fruit nurseries are the principal mango seedling source to mango growers in the study area. On the other hand, other mango seedling suppliers are not well developed in the study area and most of the mango growers lack mango grafting and nursery management knowledge and skill. Also 51.4% of the total respondent faced the challenge of grafted seedling supply as their main constraints for Mango production in their area. This generally signifies that there is no non-true seed certification system for seedling being used and hence the quality status of the existingone are in doubt. Similar Findings and conclusion have been made by Kayier Guien Chay and Amsale Workeneh(2019) 0n their review on production and marketing of Mango fruit in Ethiopia.

Further, (Abdoulaye, 2019) conducted a research project titled as ''making seed systems and markets for vegetatively propagated crops (VPCs) potato, casava and yam work for the poor'' in a cross-country study of Kenya, Nigeria, and Vietnam. The research project aimed to provide actionable evidence on policy and investment option to accelerate seed system and market developments in countries where VPCs are important to food security and agriculture developments. Using the focus group discussion and key informative interviews, he realized that one of the main challenges that faces VPCs production are those that relates to policies, institutions, and markets that shape VPCs seed system viz. quality assurances mechanisms, certifications regulations, sanitary and phytosanitary standards, and plant variety protection.

III. EFFECT OF MEDIA TYPE AND CULTIVAR ON PREPARATION OF QUALITY ROOT STOCK

While with Cassava, Potato and Yam is laudable, (Abeyrathna et al, 2016) conducted research on theEffect of Different Growing Media on Germination and Growth of Avocado {*Persea americana Mill*.) Nursery Plants in Sir Lanka. The study was conducted to find out suitable growing media to produce avocado nursery plants. Five different growing media that contain topsoil, sand, compost, burnt paddy husk and coir dust in different proportions, were evaluated and data on number of days for seed germination, seed germination rate and growth parameters of seedlings and grafted plants. The experiment was arranged as Randomized Complete Block Design (RCBD) With four replicates. Data were analysed using SAS Statistical package (version 9.2), and the result showed that T5 (Sand: Compost: Burnt paddy husk 1:1:1) and T3 (Topsoil: Sand: Compost 1:2:3) Significantly tooka smaller number of days to germinate as compared to other media. Both media recorded significantly higher root distribution in seedlings, and number of leaves and shoot length in grafted plants compared to others and thus such rooting media can be recommended for avocado seedlings production.

Similar study was conducted in Mango propagule production by**(**Sukhjit, 2017)looking the effect of Growing Media Mixtures on Seed Germination and Seedling Growth of Different Mango (Mangifera indica L.) Cultivars underSubmountainous Conditions of Punjab with the objective of evaluating how different media type would influence the quality of seedling produced. The experiment was laid in Randomized Block Design (RBD) replicated three times and the treatment was organized in the mixture of Soil+ Sand+ Farmyard manure (FYM) (1:1:1), Soil + Sand + Vermicompost (1:1:1), Soil + Sand + FYM (2:1:1), Soil + Sand + Vermicompost (2:1:1), Soil+ Sand + FYM (1:2:1), Soil + Sand + Vermicompost (1:2:1), Soil + Sand + FYM (1:1:2), Soil + Sand + Vermicompost (1:1:2) and Soil (control) all by using ripened mango fruits from healthy and disease free plants of Dusehri, Amrapali and Alphonso cultivar. The result on this experiment showed that media type (Soil + Sand + Vermicompost in the ratio of (1:1:2)had significantly higher GerminationPercentage, SeedlingHeight, NumberofLeavesandSeedlingGirth as well as few days to germinations. The maximum seedling survival (85.25%), number of roots (50.25), tap root length(30.15cm), root girth (5.5mm), root fresh weight (13.52gm) and dry weight (8.45 gm) were recorded in the same media type and ratio.

Vermi compost is said to be high in organic matter content which increases water and nutrient holding capacity of the medium for supply to the plant. It is also reported as having bioactive that is beneficial for root growth, root initiation, germination, and growth of the plant. Organic matter present in the vermi compost also do improve nutrient availability and improve phosphorus absorption. All these conditions are favourable for seed germination and hence good germination percent, high speed of emergency and good vigour. It is by this study one can conclude that using this media type and composition ration is the best for mango propagules productions.

IV. EFFECTS OF IRRIGATION FREQUENCY, AND SHADE ON GROWTH OF MANGO SEED PLANTS

As far as irrigation in mango grafting is concern (Ouma, 2008)conducted a study on Effect of different container sizes and irrigation frequency on the growth and gas exchange characteristics of mango (Mangifera indica L.) rootstock seedlings in Kenya. A collected mango seed was planted indifferent container size and the experiment was designed as completely randomized design with two treatment type one being different container size and the other one an irrigation frequency of W1 (irrigating every day), W2 (irrigating every two days), W3 (irrigating every three days).

The result from this study indicated that there was a significance increase in plant height, number of leaves, root and shoot dry weight, as well as whole plant dry weight. This agrees with the study done by (Regan, 1999) on how the limited root zone of containerized plants require frequent replenishment of water and hence this growth response. Again, there is differential sensitivity of roots and shoots to water deficit with root growth being less sensitive to water deficit and this caused the increase in root to shoot ratio as in the present study (Jones, 1992). Similar result was also observed for leaf number whereby there was an increase in leaf number with increase in irrigation frequencies and a decrease at lower irrigation frequencies. Also, Irrigation frequency increased root dry weights and lowest irrigation frequencies (W3 and W2) insmaller containers had the lowest dry weights fromsignificantcontainersize and irrigationinteraction.Similarresultswereobservedforshootdry weightsandroottoshootratio.

Another study was conducted by (Thutteet al., 2019) on the Effect of different shade conditions for success and survival of mango grafts in Badnapur India with objectives to study the percent graft success, growth performance and survival percentage of mango grafts under different shade conditions.The experiment was laid out in a Randomized Block Design with 4 treatmentsi.e., polyhouse with foggers (T1), polyhouse without foggers (T2), shade net (T3) and open condition (T4) which replicated five times. The result of the experiment was as tabulated as bellow. Data ondaystakenforsprouting,Percentagegraftsuccess,numberofshootspergraft,lengthofshoot(cm),diameterofshoot(mm),numberofleavespergraft,heightofgraftedplants(cm),diameterofrootstock(mm), diameterofscion (mm)and final survival percentage were recorded ware collected and the result was tabulated as on bellow table.

Treatments	Days taken forsprouting	Percentage of graft success %(30 DAG)	Number of shoots pergraft90DAG	Length of shoots(cm) 90DAG	Diameter of shoots(mm)90 DAG
T1	7.61	85.50	3.24	4.16	3.86
T2	8.72	75.50	2.78	3.46	3.21
T3	9.01	82.50	2.61	3.30	2.85
T4	9.52	71.50	2.38	2.74	2.52
S.Em±	0.32	1.50	0.13	0.15	0.13
CD @5%	1.00	4.64	0.40	0.46	0.40

Table 1: Days taken for sprouting, Percentage of graft success, Number of shoots per graft, Length of shoots (cm) and Diameter of shoots (mm)

The result from this observation shows that there was a significant difference with all recorded observations. Significantly maximum percentage of graft success (85.50%), number of leaves per graft (19.01), height of grafted plants (26.38 cm), diameter of rootstock (6.01 mm), diameter of scion (6.11 mm) and final survival percentage (75.50%) at 90 DAG was recorded in polyhouse with foggers condition which was closely followed by shadenet condition, and it was superior to rest of the treatments studied.This is in line with the study that was done by Malinga, Micheal (2013) on the effects of grafting technique, shade intensity and age of rootstocks on grafting success at Namanve, Uganda. From his study the observation was that Within shade intensities, mean survival percentage differed only under the 90% (F=3.83, P=0.01) shade intensity, but not under the 50% and 70% shade intensities. This observation shows that it is very important to consider a good shading condition during grafting activity for a maximum grafting survival percentage and graft take.

Apart from irrigation frequency being recorded as the determinant for good propagules preparation in Mango, the irrigation rate and frequency effects on seedling survival and growth of Vangueria infausta and Persea americana was also study by (Mng'omba et al., 2010) in Malawi Lilongwe. Two experiments were set both species in the greenhouse Experiment 1 ware (application frequency treatments) involving application of 500 ml of water to V. infausta and P. americana seedlings at (T1) daily, (T2) After every two-days (T3) four-day and (T4) six-day intervals per 1L polyethylene bag. Experiment 2 involved water application rate (treatments) of either (T1) 25 ml, (T2) 50 ml, (T3) 100 ml and (T4) 150 ml per 1L polyethylene bag and was applied every two days. In both experiments, a graduated cylinder was used to measure quantities of water applied. Water application was done during the morning hours only. The four treatments for each experiment were arranged in randomized block design with four replications. 30 seedlings per treatment for each specie ware used, however measurements were repeatedly recorded from 20 seedlings per treatment. Data on seedling survival, seedling height, root collar diameter (RCD), number of leaves and branches were recorded for both experiments. Data on seedling survival rate were analyzed using mixed models (PROC MIXED of SAS), while data on plant height, number of leaves and branches and root collar diameter (RCD), were analysed using repeated measures. The result from both experiments reveled that Water application of 50 ml at two-day interval gave more than 80% seedling survival for both species. The optimal application rate was 100 ml, which resulted in almost 100% survival for both species. Other parameters were also affected accordingly.

V. GRAFTING PRACTICES FOR PREPARATION OF CERTIFIABLE ROOT STALK AND SCION

A study done by (Alberto et al., 2017) on mango propagation with the aim of reviewing literature on mango preparation aspects highlights that in coming out with good rootstocks the first step is to collect mango fruits from a health polyembryonic trees and the seed in it must be free from pest and diseases. Under any suspicion of mango seed weevil Sternochetus (Cryptorhynchus) mangiferae attack, this seed must be eliminated immediately(Galán, 2008). Other features are Fruits should have complete maturation avoiding those over mature and/or rotten fruits due to a delay on their collections, Fruits and seeds should as much be larger as possible according with the selected cultivar since germination and vigour are positively related both to seed weight and size of cotyledon (Giri, 2018).

On the other hand, (Abdullah, 2009) conducted a study on Vigour and Morphological Characteristics of Mango Seedling Rootstock cv. 'Telor' and observed that the seedlings with high rate of germination 93.3%was the best to be considered as root stock during root stock preparation.

Further root stock scion preparation study was conducted in Nigeria by (Baita., et al 2007) on the topic titled Evaluation of different morphological types of Mango (mangifera indica l.) for use as rootstock in seedlings production. They selected four morphological types and locally named as (Binta Siga, Gwaiwar Rago, Dankamaru and Fafaranda). The aim of the experiments was to evaluate how preparation of each root stock morphotype would affect plant establishment, stem diameter, number of leaves, percentage take and general crop vigor. The methodology employed was completely randomized design with three repetitions having four morphotypes rootstocks (Binta Siga, Gwaiwar Rago, Dankamaru and Fafaranda) factorially combined with three scions (Alphonso, Peach and Taymour) as a treatment. Mango seedlings of near uniform size were collected from the base of protected mother trees of each cultivar to be used as rootstock. Data on stem girth, crop vigor, leaf area, percentage take, number of days to bud break, number of leaves per plant, number of primary roots and number of secondary roots were taken. The data were analysed using Analysis of Variance according to Steel and Torrie (1985) using the General Linear Model in SAS (1989) and the means were separated using Duncans Multiple Range Test (Duncan, 1955). Data ware presented on a tabular form as bellow.

Treatments	Stem Diam. (cm)	No.leaves/ plant	No.days to bud break	Leafare a (cm^2)	%take	No. of 1º roots2º roots	No. of Vigor	Crop
Rootstocks								
Binta Siga	1.53a	25.00a	13.55a	12.08a	71.66a	9.33a	24.33d	6.44a
G/Rago	3.17a	18.55b	9.77a	6.48a	67.22a	5.44b	70.00a	4.22b
Dankamaru	1.21a	21.00ab	15.33a	11.51a	55.00a	10.11a	61.00b	5.44a
Fafaranda	1.45a	17.66b	9.66a	12.97a	51.66a	4.00b	34.44	3.33b
SE±	1.050	3.120	2.980	4.290	9.000	1.430	4.280	0.427
Scions								
Taymour	1.51a	17.89a	13.33a	8.26a	78.75a	17.83a	60.08a	6.00a
Alphonso	1.46a	8.08b	12.83a	8.32a	50.83b	6.66b	43.50b	4.25a
Peach	2.55a	6.67b	10.08a	8.20a	54.58b	8.08b	38.75b	4.33a
SE ±	0.910	3.120	2.583	3.710	7.790	1.230	3.700	0.490
RXS Intr.	NS	*	NS	NS	NS	NS	NS	NS

Table 1: Effect of rootstock and scion on stem diameter, number of leaves per plant, number of days to bud break, leaf area, percentage take, number of primary roots per plant, number of secondary roots per plant and vigor score of mango at Bayero University, Kano in 2005/06 2006/2007 wet seaso

The result shows that a better preparation of root stock and scion results into a good mango propagule and this should be kept in mind as an important aspect in developing a certifiable mango propagule.

VI. RESEARCH GAP AND FUTURE TRENDS

Despite different study being conducted in different area showing the best practices for preparation of different nontrue seed propagules, but they have not shown a link of the practices with the certification standard practices and whether such certification is under implementations by the respective regulatory body.

Seed certification is important in maintaining and making available to the public, through certification, high quality seeds and propagatingmaterials of notified kind and varieties so grown and distributed as to ensuregenetic identity and genetic purity. Seed certification is also designed toachieve prescribed standards. In Tanzania, seed standards for majority crops propagated from true seeds are well established and regulated by the Tanzania Official Seed Certification Institute (TOSCI). Development of seed standards of the vegetatively propagated seeds as NTS in Tanzania is at its infancy although certification of NTS might be in force in a near future (TOSCI, personal communication). Certification is coming late at a time when the seed industry is already trading informally, millions of propagules worth millions of Tanzanian shillings countrywide. According to the Tanzanian Seed Act 2003 seed certification is based on the premise that proper identification of crop varieties is essential to everyone who handles seed from the breeder, commercial grower, seed cleaner, and seed distributor, to the farmer or rancher who purchases the seed.This study will help in establishing a practice that should be practiced by mango propagule producers for producing a certifiable Mango propagule. It will also help TOSCI in establishing the certification standard for Mango in Tanzania.

VII. CONCLUSION

The safe of farmers and hence food and nutritional security is normally rooted on seed quality. The quality is not decided or determined by farmers locally. A government regulatory should control the quality and ensure the availability. Mango non-true seed system in Tanzania needs to be controlled and or formalized in the sense that farmers are supplied with the quality propagules and the business itself is also formalized.

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