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AVOCADO ROOTSTOCK PROPAGATION TECHNIQUES TO SUPPORT THE READINESS OF NGESREPBALONG VILLAGE, LIMBANGAN KENDAL AS AN AVOCADO CENTER

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ABSTRAK

Desa Ngesrepbalong di Kecamatan Limbangan, Kendal diketahui rawan longsor. Mitigasi longsor dilakukan melalui penanaman pohon berakar dalam. Desa ini hingga akhir 2023 tergolong desa berkembang. Upaya mewujudkan Ngesrepbalong sebagai sentra alpukat membutuhkan intensifikasi budidaya alpukat unggul yang membutuhkan ketersediaan bibit secara masal. Permasalahannya, rootstock pada grafting alpukat terbatas karena satu buah alpukat hanya menghasilkan satu biji. Permasalahan produksi mitra sasaran "Gunung Berkah" ini diatasi melalui tahapan sosialisasi, pelatihan, penerapan, dan pendampingan, monitoring dan evalusi, serta memastikan keberlanjutannya menggunakan teknik pembelahan biji/embrio alpukat menjadi minimal 2 atau lebih. Hasil kegiatan pengabdian menunjukkan 100% hasil pembelahan biji berhasil hidup menjadi rootstock normal yang kemudian menjadi 150 bibit alpukat unggul melalui grafting. Perbedaan rootstock hanya pada ketinggiannya. Efisiensi perbanyakan rootstock untuk kelompok "Gunung Berkah" direkomendasikan untuk mengkombinasi pembelahan biji/embrio dengan perlakuan lain seperti pemotongan bagian bawah biji alpukat dan pemberian hormon tumbuh. Ketersediaan rootstock mempercepat ketersedian bibit yang dibutuhkan untuk itensifikasi alpukat unggul menuju terwujudnya Ngesrepbalong sebagai sentra alpukat unggul.

ABSTRACT

Ngesrepbalong Village in Limbangan District, Kendal, is known to be prone to landslides. Landslide mitigation through planting deep-rooted trees. This village was classified as a developing village until the end of 2023. Efforts to realize Ngesrepbalong as an avocado center required intensifying superior avocado cultivation, which involved mass availability of seeds. The problem was that the rootstock in avocado grafting was limited because one avocado only produced one seed. The production problems of the target partners of "Gunung Berkah" were overcome through socialization, training, implementation, assistance, monitoring and evaluation, and ensuring its sustainability by splitting avocado seeds/embryos into at least 2 or more. The community service activities showed that 100% of seed splitting results succeeded in growing into standard rootstock, which then became 150 superior avocado seedlings through grafting. The difference in rootstock was only in its height. For the efficiency of rootstock propagation for the Gunung Berkah group in the future, it is recommended that seed/embryo splitting be combined with the treatment of cutting the bottom of the avocado seed, giving growth hormones, and using the right planting media. The availability of avocado rootstock accelerated the availability of seeds for the intensification of superior avocado cultivation towards the realization of Ngesrepbalong as a superior avocado center.

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INTRODUCTION

Administratively, Ngesrepbalong is located in Limbangan District, Kendal Regency, Central Java, covering an area of 17.78% (12.75 km2) of the total district area. This area is reported to be prone to landslides because the slope is more than 30% (Laraswati *et al*., 2023). Landslide mitigation efforts have been carried out through planting deep-rooted trees and preventing tree felling. Deep-rooted trees can store and retain water, so that landslides can be minimized (Spiekermann *et al*., 2022; Zayadi *et al*., 2023). The Village Development Index (VDI) of Ngesrepbalong until 2023 showed that the village is classified as a developing village (DK dan I Kab Kendal, 2022). The development of Ngesrepbalong as an avocado center is one of the programs that will increase VDI. Intensification of avocado planting is expected to increase VDI while reducing the potential for landslides. The growth and development of avocados are in accordance with the Ngesrepbalong agroclimate, which is located at 600-1200 meters above sea level (masl) (Nugraha, 2022). Avocados can be produced at an altitude of 200-1000 meters above sea level, and grow optimally at 700 meters above sea level (Kawilarang *et al*., 2022; Widianti *et al*., 2022). Therefore, avocados grow wild in the Ngesrepbalong Village area.

Wild avocados produce low-quality fruit, low productivity, and relatively long fruiting times. Since 2022, wild avocados in the Ngesrepbalong area have been grafted using top working (TW) and grafting techniques to improve the quality of the fruit (Laraswati *et al*., 2023; Retnoningsih *et al*., 2024). Several mature trees have been grafted using the TW technique with superior Deana scions (Retnoningsih *et al*., 2024). TW aims to obtain superior plants using mature tree rootstocks grafted onto selected superior scions. The TW technique on perennial fruit species has been proven to accelerate the reproductive period (Gregoriou *et al*., 1984) with fruit quality and productivity as the scion used. The difference between grafting and TW is that the rootstock is a young seedling, usually less than one year old. Scion is taken from a selected parent tree, while rootstock is from the same type of plant seedling. Rootstock is generally resistant to pests and diseases and is resistant to unfavorable media environments.

The problem with grafting avocados is the limited number of seeds for rootstock. One avocado only has one seed, so it is necessary to use a technique to multiply rootstock, including dividing the avocado seed/embryo into at least 2 or more. This technique can produce 2-4 rootstocks from 1 avocado seed (Pratiwi, 2023). The faster and more rootstock is available, the faster and more superior avocado grafting can be produced, so that the development of Ngesrepbalong Village as a superior avocado center can be realized. Intensification of superior avocado is needed to improve community welfare through the utilization of local natural resources. Most wild avocados are not superior varieties. Cross-pollination produces offspring with different genotypes from their parents (Abbas *et al*., 2017; Selak *et al*., 2021). The stability of fruit quantity and quality can only be guaranteed through vegetative propagation because the results have the same genotype as the parent. Therefore, the application of grafting techniques is important to accelerate the intensification of superior

avocados in this area.

The target partner for this activity is the "Gunung Berkah" avocado farmer group in Gunungsari Hamlet, Ngesrepbalong Village. The Pluang variety is the only superior avocado that has been cultivated. The harvest of this variety is quite promising, even though the maintenance is minimal. Each Pluang avocado tree produces 50-100 kg/harvest, so that farmers' income is around 5-10 million per year, meaning that increasing the number of superior avocado trees can increase farmers' income. Increasing the population of superior avocados is the first step in realizing Ngesrepbalong as a green economy-based avocado center. The green economy aims to improve community welfare and equality while reducing the risk of environmental damage (Anwar, 2022; Firmansyah, 2022; Mubarok, 2023). The implementation of a green economy is reported to be able to minimize carbon dioxide emissions, conserve natural resources, and be socially just (Bappenas, 2023). Emission reduction occurs through the process of photosynthesis (Jauhari *et al.*, 2021). The realization of Ngesrepbalong as a green economy-based avocado center is expected to be able to improve the economy and welfare of the community, while ensuring that ecological conditions are maintained.

The purpose of this community service activity is to apply avocado seed/embryo cutting/splitting techniques to increase and accelerate the availability of rootstock. Increasing and accelerating the availability of rootstock can increase and accelerate the availability of superior grafted seedlings.

METHOD

Community service activities were carried out from May to November 2024 for the target partners of avocado farmers "Gunung Berkah". Community service activities were carried out in 5 stages, including socialization, training, application and assistance of seed/embryo splitting techniques, monitoring and evaluation, and sustainability programs presented in Figure 1. The purpose of training, application of technology, and assistance was to ensure that farmers could properly divide avocado seeds/embryos into at least two to four avocado seed pieces and could live like normal seeds, so that many rootstock seeds are obtained for grafting propagation.

The avocado seed splitting technique was carried out in stages as follows. The avocado seeds were conditioned to be moist by wrapping/covering the cleaned seeds with a wet towel/cloth and keeping them moist for 7-10 days. Seeds that split naturally due to imbibition stimulated embryo enlargement. Seeds with enlarged embryos were then split into two or four using a sharp and clean knife. Embryo splitting must be ensured to bring part of the embryo into each seed piece. The 2-3-month-old rootstock was then grafted with Deana's superior avocado scion.

Figure 1. Community Service Activities for Target Partners of Farmer Group "Gunung Berkah", Gunungsari Hamlet, Ngesrepbalong Village, Limbangan, Kendal

RESULTS AND DISCUSSION

The target partners of avocado farmers "Gunung Berkah" had been trained in avocado grafting in previous community service activities in 2023 (Retnoningsih *et al.*, 2024). The empowerment of target partners in 2024 was measured through the successful application of technology to obtain several rootstocks through avocado seed/embryo splitting. The sustainability of the program was carried out through periodic assistance, especially in the maintenance of rootstocks and grafted seedlings, by providing assistance with fertilizers and the necessary equipment. The problems of production aspects that were successfully overcome in this community service activity are presented in Table 1.

Table 1. Achievement of empowerment of the target partner "Gunung Berkah" in the production aspect

Aspect	Achievement	Description
Production	a. Finalization of the repair of the 8x18 square meter avocado nursery house, which is ready and suitable for use for grafting propagation.; b. Addition of adequate equipment (5 branch shears, 5 grafting knives, and 1 box of razor blades), grafting materials in the form of superior Deana avocado scions (100 branches), plastic covers, grafting plastic (PE), and polybags; and maintenance materials in the form of 2 sacks of NPK 16:16:16 fertilizer (@ 25 kg) and 4 packs of 250 gram biopesticides; and c. Producing 150 Deana avocado grafting seedlings with rootstock from seeds/embryos splitting, each seed is divided into 2-4, depending on the size of the seed; Deana avocado branches can become 2-4 scions according to the number of buds on each branch	Deana avocado is a new superior avocado accession with characteristics of dark yellow flesh, an average weight of 1 kg containing 2-3 fruits, a savory and legit taste, so it can be eaten without adding sweeteners, the flesh is quite thick, 2-2.5 cm.

The results of the application of the seed/embryo splitting technique showed that all seeds whose embryos were divided into 2 or 4 were 100% successful and could grow as rootstocks in seeds without being split. Rootstock growth was observed one week after embryo splitting to ensure live seeds and one month to ensure normal rootstock growth. The difference was in the height of the rootstock (Figure 2). The empowerment of the target partner of farmers in Gunungsari Hamlet, especially in the application of rootstock propagation techniques, was measured by their success in multiplying rootstocks through embryo splitting techniques. The sustainability of the program was carried out through the maintenance of rootstock seedlings and grafted seedlings through mentoring and assistance with fertilizers and equipment.

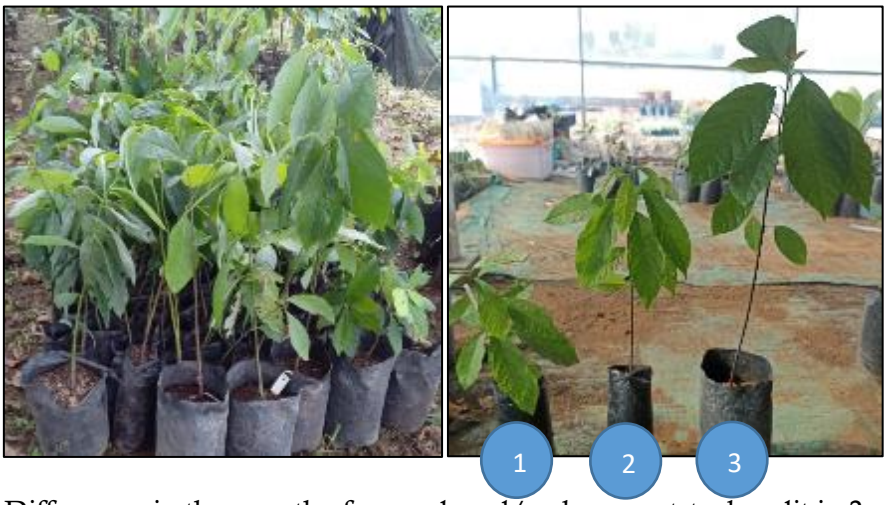

Figure 2. Differences in the growth of normal seed/embryo rootstock, split in 2 and 4

Normal growth in Figure 2 was number 3; shorter growth in number 2, the seed was split into 2, and the shortest growth in number 1, the seed was split into 4. Although this seed/embryo splitting technique had only been trained to target partners, its success was optimal because, technically, seed/embryo splitting was easy to do. If each part of the seed splitting carried part of the embryo, it was certain that the rootstock could live and grow completely as the rootstock from whole seeds. Therefore, this seed/embryo splitting technique in the future has the potential to overcome the scarcity of rootstock to support cultivation intensification to develop seedling businesses and develop avocado-based processed products.

Grafting is known to be the most ancient agricultural technique known to humans since 2000 BC. This technique has contributed to the development of contemporary science and technology in various crops. Grafting provides an opportunity to utilize natural genetic variation for certain root traits that affect the phenotype of the scion. Rootstock can manipulate the morphology and physiology of the scion and can manage biotic stresses including leaf and soil pathogens, arthropods, viral diseases, weeds and nematodes, as well as abiotic stresses such as thermal stress, drought, salinity, nutrient deficiencies and imbalances in the soil, adverse soil pH, heavy metal contamination and organic pollutants (Mudge *et al.*, 2009). Therefore, grafting is a means of securing the stability of crop yields and quality in a sustainable manner (Teressa *et al.*, 2021).

The results of the study showed that before avocado seeds were planted, it was more effective to treat them so that they would germinate faster and healthier. The faster they germinated, the faster the seed/embryo splitting was carried out. The combination of peeling and slicing the seed tip significantly increased germination compared to peeled seeds alone. This community service activity only peeled the skin without cutting the tip. The splitting of the seed/embryo forward needed to be applied together with slicing the seed tip. Slicing on the side of the seed was also reported to significantly increase germination time (Bergh, 1988). Seeds that were not treated before planting took longer and therefore cost more because labor requirements increased over time. Other studies have shown that cutting the seed tips is more effective (Gill, 2016). The skill of cutting the tip of avocado seeds needed to be trained to Gunung Berkah partner farmer groups so that nursery activities were more efficient. This seed cutting treatment had been tested because it had been applied by farmers from various parts of the world, in Argentina (Martinez *et al.*, 1969), Siprus (Gregoriou *et al.*, 1984), Florida (Kadman, 1960), Israel (Borys *et al.*, 1985), Meksiko (Ruehle, 1963), Puerto Riko (Hume, 1951), dan Afrika Selatan (Malan & Muelen, 1954).

The media was important to pay attention to because it determined the quality of the seeds (Abeyrathna *et al.*, 2016). Avocado seedling growth was hampered in nurseries with poor drainage. The use of a mixture of sand, compost, and rice husk charcoal in a ratio of 1:1:1 and a mixture of topsoil, sand, and compost in a ratio of 1:2:3 showed the fastest germination time compared to other types of media mixtures (Kuswara & Marta, 2016). Both types of media mixtures supported root growth and development, and a higher number of leaves and shoot length compared to other media. Other research results using a balanced mixture of soil and manure provided the best seedling growth (Mahbou *et al.*, 2022). This finding could be applied to complement the success of the Gunung Berkah farmer group in providing rootstock to accelerate the germination of avocado seeds. Avocado cultivation needs to be made into a sustainable production system. The main requirement is to produce seeds with specific genetic identity, short germination time, and very good quality.

One of the determining factors of rootstock quality was seeds weighing between 40 - 50 grams, which was the optimal weight for rootstock (Lozi *et al.*, 2018). The percentage of germination of medium-sized seeds was the highest compared to small seeds. Large seeds produced larger, stronger shoots than shoots from medium and small seeds. Therefore, to meet the availability of rootstock, the use of medium to large-sized seeds was recommended. Germination and growth were faster, so that mass provision of rootstock was more efficient (Shafira, 2023). The use of hormones to accelerate seed germination could be done by soaking the seeds in 400 ppm GA3 (Pratiwi, 2023). Seeds could germinate earlier, around 13.00 days, 50% of seeds germinated on average at 19.33 days, and the highest germination percentage was up to 95.22%, with maximum shoot length and optimal vigor index.

Avocado is known as a horticultural commodity that has a high economic value (Widianti *et al.*, 2022). The avocado seed/embryo splitting technique can be used to increase the population of superior avocados or the number of superior grafting seedlings. The business of selling

superior avocado seedlings on a land area of only 1000 m2 has reportedly provided profits in a relatively short time (Kartikasari, 2023). A farmer group with 10 members on land less than 1000 m2 requires an average production cost of Rp. 20,997,515/season with an average total income of Rp. 60,000,000/season (Fatma *et al*., 2022). The superior avocado seedling business can be duplicated by the Gunung Berkah farmer group, considering that the development of large-scale avocado gardens is currently trending. The skills of partners in multiplying rootstock through seed/embryo splitting support efforts to expand cultivation and superior avocado nurseries, as well as avocado-based product processing businesses, so that avocado centers can be realized.

Maintenance of grafting seedlings and plants in farmer groups, such as soil loosening, watering, pruning plants, pest and disease control, and fertilization, can be done together in a cooperative manner (Fatma *et al*., 2022). This condition allows each member of the farmer group to establish closer social relationships with other members so that the group's business continues to grow. The members of the Gunung Berkah farmer group, which was limited to only 9 people, their future nursery business could involve farmers or communities who had sufficient land area to participate in maintaining the seedlings until they were ready to be sold, with a profit sharing of Rp 500,-/seedling. Group businesses like this reported an average surplus income for each avocado farmer of Rp 20,188,550/year. The total household expenditure of farmers was Rp 19,858,800/year, and the total income was Rp 40,047,350/year (Kawilarang *et al*., 2022).

Avocado nursery efforts needed to be designed so that the risk of disease attacks on seedlings was minimal, because it could be a serious threat to avocado producers (Dewi *et al*., 2022). This means that efforts to develop avocado centers need to consider the use of seeds that must be guaranteed safe. The procurement of rootstock needs to consider the possibility of root rot attacks caused by Phytophthora cinnamomi. Experience in the field showed that metalaxyl fungicides and bioagents were effective in controlling P. cinnamomi. Biological control of avocado root rot could also be overcome with biofungicides Trichoderma spp. and P. fluorescens (Sumida *et al*., 2020). Trichoderma spp was widely used as a raw material for fungicides, so its use was a determining component in the success of avocado nurseries.

In efforts to develop avocado centers, it should be noted that avocado cultivation is determined by the success of the nursery phase. Young seedlings must be monitored and cared for so that they can adapt to the environment. Important stages in producing seedlings included 1) the seed germination phase for rootstock production; 2) transferring the seedlings into polybags; and 3) fertilization to increase the diameter of the rootstock stem so that grafting is easy to do. The nursery phase requires an understanding and skill in propagation and fertilization. Optimizing rootstock for grafting included 1) using the right planting media to increase the growth rate and root health so that it produces adequate root volume for seedlings; 2) ensuring the ideal transplant time; and 3) fertilizing with organic fertilizers. The type of media shows a very significant effect. Sawdust and soil media affect germination 8 days faster than sand media. The seed germination rate is higher in sawdust and

soil media. Transplanting seedlings on the 40th day provides better seedling growth and is time efficient, especially in terms of stem length and diameter (Hakimi *et al.*, 2020).

The use of growth hormones increased the success of grafting. An auxin concentration of 200 ppm gave the best results in the growth of avocado grafting seedlings. The length of the scion also showed a very significant difference in the age of bud break, age of shoot growth, increased in scion length, shoot length, number of branches, diameter of the lower stem and plant height and was significantly different in the variable number of shoots (Supriyanto & Yulianto, 2022). The interaction of auxin concentration and scion length on the growth of avocado seedlings was very significantly different in shoot length, increase in scion length, and number of branches. The best interaction was 200 ppm auxin with a scion length of 15 cm. The research findings could be applied to accelerate the propagation of avocado grafting seedlings using rootstock from seed/embryo splitting. Propagation of avocado plants through grafting required rootstock with fast and uniform growth to support fast and healthy shoot growth (Jayswal & Lal, 2017). The most common problem was that seed growth was not uniform because it did not grow simultaneously. Injury to the bottom of the seed and soaking in GA3 solution (250 ppm or 500 ppm) could accelerate seed germination and avocado seedling growth. This growth was characterized by an increase in plant height, stem diameter, number of secondary roots, length of primary roots, and fresh root weight. The GA3 application tended to reduce the average number of shoots, but shoot growth in grafting increased. Another problem faced in avocado grafting was the success of graft union formation, which depended on scions and growth regulators that stimulated callus formation and vascular differentiation. Priming avocado seeds with 10 g/1 KNO3 had been shown to accelerate germination and increased avocado seedling growth. Large avocado seeds germinated faster and produced higher seedling growth than seedlings from small seeds. Application of BAP 50-100 ppm could increase the success of grafting and shoot growth of avocado plants (Teressa *et al.*, 2021).

CONCLUSION

The development of Ngesrepbalong as an avocado center required intensification of superior avocado cultivation with the hope that VDI would increase and landslides would decrease. Intensification of avocado cultivation, which required superior avocado seeds in large quantities, was most efficiently propagated through grafting. The problem was the limited availability of rootstock because one avocado only produced one seed. The problem of avocado farmers "Gunung Berkah" in this production aspect was overcome through training, application, and assistance in the technique of multiplying rootstock by splitting avocado seeds/embryos into at least 2 or more. The results of the activity showed that 100% of the seed splitting successfully survived into normal rootstock, which was then used as rootstock for 150 grafting seedlings. The difference in rootstock from seed/embryo splitting was only in its height. For the efficiency of rootstock propagation for the Gunung Berkah group in the future, it is recommended that seed/embryo splitting be combined with the treatment of cutting the bottom of the avocado seed, giving growth hormones, and using the right planting media. The availability of avocado rootstock accelerated the availability of seeds for the intensification of superior avocado

cultivation towards the realization of Ngesrepbalong as a superior avocado center.

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