بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Graduate Studies

Effect of Bee glue (Propolis) Powder Aqueous Extract, Potassium Nitrate and their Mixture on Seed Germination and Some Growth Parameters of Groundnut (*Arachis hypogaea* L.)

تأثير المستخلص المائي لمسحوق صمغ النحل، نترات البوتاسيوم وخليطهما على إنبات البذور وبعض قياسات النمو في الفول السوداني

A thesis Submitted in Partial Fulfillment of the Requirements for the M.Sc. Degree in Plant Protection

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April 2018

الآية

قال الله تعالى :

۞ تِلۡكَ ٱلرُّسُلُ فَضَّلۡنَا بَعۡضَهُمۡ عَلَىٰ بَعۡضٖۘ مِّنۡهُم مَّن كَلَّمَ ٱللَّهُۖ وَرَفَعَ بَعۡضَهُمۡ دَرَجَٰتٖۚ وَءَاتَيۡنَا عِيسَى ٱبۡنَ مَرۡيَمَ ٱلۡبَيِّنَٰتِ وَأَيَّدۡنَٰهُ بِرُوحِ ٱلۡقُدُسِۗ وَلَوۡ شَآءَ ٱللَّهُ مَا ٱقۡتَتَلَ ٱلَّذِينَ مِنۢ بَعۡدِهِم مِّنۢ بَعۡدِ مَا جَآءَتۡهُمُ ٱلۡبَيِّنَٰتُ وَلَٰكِنِ ٱخۡتَلَفُواْ فَمِنۡهُم مَّنۡ ءَامَنَ وَمِنۡهُم مَّن كَفَرَۚ وَلَوۡ شَآءَ ٱللَّهُ مَا ٱقۡتَتَلُواْ وَلَٰكِنَّ ٱللَّهَ يَفۡعَلُ مَا يُرِيدُ ﴿٢٥٣﴾ يَٰٓأَيُّهَا ٱلَّذِينَ ءَامَنُوٓاْ أَنفِقُواْ مِمَّا رَزَقۡنَٰكُم مِّن قَبۡلِ أَن يَأۡتِيَ يَوۡمٞ لَّا بَيۡعٞ فِيهِ وَلَا خُلَّةٞ وَلَا شَفَٰعَةٞۗ وَٱلۡكَٰفِرُونَ هُمُ ٱلظَّٰلِمُونَ ﴿٢٥٤﴾

سورة البقرة الآية (253-254)

DEDICATION

For the soul of my sister

MONA,

my mother,

my father,

my wife and sons,

all people whom I love them so much

And

Of course too you Readers

With my best wishes

Sief Eldinn Gadkarim

ACKNOWLEDGMENTS

First and above all, I praise Allah, the almighty for providing me this opportunity and granting me the capability to proceed successfully. This thesis appears in its current form due to the assistance and guidance of several people. I would therefore like to offer my sincere thanks to all of them. I wish to express my deepest gratitude and sincere thanks to my supervisor **Dr. Abd Elbagi Elsayed Ali**, for his suggestion of the project, continued interest, genuine guidance, patient assistance and supervision through the course of this study.

My deep thanks and appreciation is also to my friend, **Dr. Hatim Gumaa Elmardi Siddig** who gave much effort and valuable times promoting and financing this project with full energy and kind manner, I hope him long life with full happiness and pleasure.

Thanks are also extended to my brother **Gafar Bashir Malik** Ustaza **Moda Ibrahim Hamed**, Ustaza **Wegdan Abaas**, Ustaza **AAsha Beakheet**, Ustaza **Sara**, Ustaza **Amaney**, Ustaza **khansa Alfahashim** and Ustaz **Zean Alabdeen** for their help during the course of this study.

Thanks are also to my friends Mr. **Wael Malik** and Mr. **Moalla Bushraa Mohammed**

I acknowledge with respect, the help rendered to me by colleagues

Sincere thanks are also extended to those who helped me in various ways and encouraged me to achieve and finish my research work. Last but not least, thanks are extended to my family, specially my father and mother for financing my studies and helping me in many ways to finish this study.

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ABSTRACT

Groundnut is considered one of the major oil seed crops, widely grown in tropical and subtropical regions of the world. Its multiple uses make it as an excellent cash crop for domestic market and for foreign trade as well. The low germination level and poor growth of the crop in some conditions due to plant pathogens and other causal agents is one of the factors behind low productivity. Considering the irrational use of synthetic pesticides to control various pests and diseases of the crops and their adverse effects on environment, natural habitats through their residual toxicity, this study which was conducted under laboratory conditions of College of Agricultural Studies "Shambat", Sudan University of Science and Technology, aimed to investigate the effect of bee glue (Propolis) powder aqueous extract, potassium nitrate and their mixture on seed germination and some growth parameter of groundnut (*Arachis hypogaea* L.). Three concentrations of aqueous extract of Propolis powder, potassium nitrate solution and their mixing up, each of 5, 10 and 15% were used in addition to untreated control. The assessment of their effect on seed germination and plant health was recorded through the percentage of germination and their influence on growth parameters. The results revealed that all concentrations of the aqueous extracts of bee glue powder, potassium nitrate and their mixture increased invariably the seed germination and growth parameters compared to control. The increase in germination percent ranging from 33.33% due to 5% potassium nitrate concentration to 80% due to 15% aqueous extracts bee glue powder concentration compared to 6.67% untreated control. The highest concentration of bee glue powder extract (15%), mixture of Propolis and KNO_3 (7.5+7.5%) and the KNO_3 alone (10 and 15%), gave the highest increase in germination percent (80.00, 66.67 and 40.0%) respectively compared to the untreated control (6,67%) in day three after inoculation. Among the treatments tested that of Propolis at all concentration (5, 10 and

15%) was generally the most effective in increasing the germination of seeds and gave significantly the highest percent germination, 80.00, 73.33 and 66.67 % respectively than its equivalents potassium nitrate and their mixture. Also the results showed that application of all treatments gave pronounced increase in number of leaves and fresh and dry weight compared to control. Moreover, concentration of each Propolis powder aqueous extract as well as that of potassium nitrate and their mixture reacted differently regarding their effect on germination and growth parameters. Generally, the results showed that the treatments activity increase with increase in concentration. Likewise, the test crop differs in its response to the different concentrations of treatments. To my knowledge, the current results were considered the first of its kind in the Sudan and hence it is promising and encouraging using Propolis for enhancing germination and growth parameters in other crops.

ملخص البحث

يعتبر الفول السوداني احد أهم المحاصيل الذي يزرع في الأقاليم الإستوائية وشبه الاستوائية حول العالم. نسبة لتعدد استعمالاته أصبح من أميز المحاصيل النقدية على مستوى السوق المحلى والتجارة الخارجية. إن تدنى نسبة الإنبات وقلة نمو المحصول في بعض الأحول نسبة للممرضات النباتية ومسبباتها هي أحدى الأسباب وراء تدنى الإنتاجية. آخذين في الاعتبار الإستعمال الغير مرشد للمبيدات المصنعة لمكافحة آفات وأمراض المحاصيل وتأثيراتها الضارة على البيئة والحياة الطبيعية عن طريق مخلفاتها السامة، هذه الدراسة والتي أجريت تحت ظروف المعمل بكلية الدراسات الزراعية بشمبات، جامعة السودان للعلوم والتكنولوجيا، تهدف إلى التحري عن تأثير المستخلص المائي لمسحوق صمغ نحل العسل (بروبوليس)، محلول نترات البوتاسيوم وخلطيهما على إنبات بذور ومعامل نمو الفول السوداني. استخدمت ثلاثة تراكيز (5، 10 و 15%) لكل من المستخلص المائي لمسحوق صمغ نحل العسل، محلول نترات البوتاسيوم وخلطيهما إضافة إلى الشاهد. تم تقيم أثرهما على إنبات البذور وصحة النبات بتسجيل نسبة الإنبات والتأثير على معامل النمو. أوضحت النتائج أن كل تراكيز المستخلص المائي لمسحوق صمغ نحل العسل (بروبوليس)، محلول نترات البوتاسيوم وخلطيهما قد زادت نسبة إنبات البذور ومعامل النمو بصورة دائمة مقارنة بالشاهد. تراوحت نسبة الزيادة في الإنبات بين 33.33% الناجمة عن نترات البوتاسيوم بتركيز 5% إلى 80.00% الناجمة عن التركيز 15 % مقارنة مع 6.67 % للشاهد. كما أن التراكيز الأعلى لكل من المستخلص المائي لمسحوق صمغ نحل العسل (15%)، وخليط مسحوق صمغ عسل النحل ومحلول نترات البوتاسيوم (7.5+7.5%) ومحلول نترات البوتاسيوم 10 و 15 % أعطت أعلى نسبة إنبات 80.0, 66.67 و40.00 % على التوالي مقرنة بالشاهد (6,67%) في اليوم الثالث من بداية التجربة. أما فيما بين المعاملات التي اختبرت فإن كل تراكيز المستخلص المائي لمسحوق صمغ نحل العسل (5, 10 و15%) عامة قد كانت الأكثر فعالية في زيادة إنبات البذور قد أظهرت اعلي نسبة إنبات 80.00، 73.33 و66.67 % وتأثير معنوي هام على التوالي أكثر من رصفائها نترات البوتاسيوم والخليط. أظهرت الدراسة أيضا أن كل المعاملات قد أعطت زيادة واضحة في عدد الأوراق والوزن الأخضر والجاف للنبات مقارنة بالشاهد. أيضا كل تراكيز المستخلص المائي لمسحوق صمغ نحل العسل, ومحلول نترات البوتاسيوم وخليطهما قد تفاعلت كل على حده فيما يختص بتأثيرهما علي نسبة الإنبات ومعامل النمو. عموما أظهرت النتائج أن فعالية المعاملات تزداد بزيادة تركيز المحاليل المختبرة. من الواضح أيضا من النتائج أن المحصول المختبر متباين في استجابته للتراكيز المختلفة. حسب علمي النتيجة الحالية تعتبر الأولى من نوعها في السودان وبالتالي هي واعده وتشجع على استعمال مسحوق صمغ عسل النحل في تحسين إنبات ونمو محاصيل أخرى.

CHAPTER ONE

INTRODUCTION

Groundnut (*Arachis hypogaea* L.), which belong to family Fabaceae is a major oil seed crop widely grown in tropical and subtropical regions of the world, and is an important source of protein .The crops believed to be originated from South America (Weiss, 2000). Its cultivation is mostly confined to the tropical countries ranging from 40º N to 40º S. Major groundnut producing countries are: China (40.1%), India (16.4%), Nigeria (8.2%), United State of America (5.9%), Indonesia (4.1) and Sudan (30.6%) (Nwokoto, 1996). Worldwide, approximately 25.7 million tons of groundnuts are produced annually from about 21 million hectares of cropped land. Asia alone produces 17.9 million tons, 70% of global production. Africa produces another 20%. About 60% of Africa's production comes from Western Africa (FAO, 2006).

In Sudan, groundnut is important oil crop for domestic cash marketing and for foreign trade. Area under cultivation of the crop is about 0.8 million hectares with an estimated total production of 0.4 million ton (Ishag, 1986). The crop is grown under irrigation in the central clay plains and in the rain-fed areas in the sandy soils of Western Sudan. About 85% of the national productions come from the traditional rain- fed sector of western Sudan. In such area, groundnut comes after sorghum and pearl millet. Barberton, Sodiri and Gubiesh, are widely grown cultivars characterized by early maturity, tolerance to drought stress and high pod yield. Several varieties and lines are tested and evaluated in Western Sudan (Osman, 2003).

Groundnut seeds are nutritional source of vitamin E, niacin, falacin, calcium, phosphorus, magnesium, zinc, iron, riboflavin, thiamine and potassium. The kernels are consumed directly as raw, roasted or boiled

kernels or oil extracted from the kernel is used as culinary oil. It is also used as animal feed (oil pressings, seeds, green material and straw) and industrial raw material (oil cakes and fertilizer). These multiple uses of groundnut plant make it an excellent cash crop for domestic markets as well as for foreign trade in several developing and developed countries (Nwokoto, 1996).

Propolis is a wax –like resinous substance collected by honey bees from tree buds or other botanical sources and used as cement to seal cracks and open spaces in the hive, its color varies from green to brown and reddish, depending on its botanical source. Honey bees use the Propolis as antimicrobial to prevent infection with disease and parasites in the hive (Burdock, 1998).

Potassium nitrate (KNO3) is a soluble source of two major essential plant nutrients. It is commonly used as a fertilizer for high-value crops that benefit from nitrate (NO3-) nutrition and a source of potassium (K+) free of chloride (Cl) (Khalifa,et al., 2009).

In some cases in the clay and sandy soils, the low germination of groundnut seeds was caused by many factors such as plant pathogens, poor storage and genetic factors.

Study objective:

The objective of this study is to investigate the effect of the Bee glue (Propolis) powder aqueous extract, potassium nitrate and their mixture on seed germination and some growth parameters of groundnut (*Arachis hypogaea*).

CHAPTER TWO

LITERATURE REVIEW

2.1. The groundnut

Groundnut or peanut (*Arachis hypogea Linn*), is a plant which belongs to the family of Fabaceae (Eke-Ejiofor, *et al.*,2012). Botanically, groundnut is a leguminosae crop although it is widely identified as a nut and has similar nutrient profile with tree nuts (Ros, 2010). This annual plant is generally distributed in the tropical, sub-tropical and warm temperate areas and represents the second most important legume in the world based on total production after soybean (Pattee and Young, 1982; Redden, *et al.;* 2005).

2.1.1. Origin and Distribution

The groundnut originated in Latin America and was introduced to African continent from Brazil by the Portuguese in the 16th century (Abalu and Etuk, 1986; Adinya *et al*., 2010; Hamidu *et al*., 2007).

Groundnut (*Arachis hypogaea* L.) is among the major oil seeds in the world. China, India and United State of America are the main producers of groundnuts to the rest of the world (Campos-Mondragon *et al*., 2009).

Groundnut, (*Arachis hypogaea* L.) also known as peanut or earthnut is a native to a region in eastern South America (Weiss, 1983). Groundnut is now grown worldwide in the tropical and temperate zones primarily as an oil seed crop (Bansal *et al*., 1993). The fat content in groundnut has been largely studied. In general, groundnuts contain 50-55% fat of which approximately 30% is linoleic acid and 45% is oleic acid. High-oleic groundnuts rather than normal groundnuts have increased self life and thus improve the oxidative stability of peanut products (Isleib *et al*., 2006). Groundnut seed contain 44-56% oil and 22-30% protein on a dry seed basis and is a rich source of minerals (phosphorus, calcium, magnesium and potassium) and vitamins (E, K and B group) (Savage and Keenan, 1994).

2.1.2. Groundnut growth and development

Growth of peanut was studied by Willams (1976), who found that growth peaked at 150 days after planting. Leaf weight, leaf area, stem weight and leaf area index increased up to 118 days after planting and pod yield increased from 118-115 days after planting and then slowed down.

2.1.3. Groundnut classification

Class: Magnoliopsida

Order: Fabales

Family: Leguminosae

Genus: *Arachis*

Species: *hypogaea*

Groundnut a species in the family leguminosae is an annual legume. It is known by many local names, including peanut, earthnut, monkey-nut and goobers. The crop is mainly grown for oilseed, food, and animal feed (Pande *et al*., 2003; Upadhyaya *et al*., 2006). It is the world's 13th most important food crop, 4th most important source of edible oil and 3rd most important source of vegetable protein (Taru *et al*., 2010).

Groundnut is useful in the treatment of haemophilia, can cure Stomatitis and prevent diarrhea, and is beneficial for pregnant women, nursing mothers and growing children (Akobundu, 1998). The kernels can be eaten raw, roasted or boiled and the groundnut vines are used as fodder for cattle (Pompeu, 1980; Hong *et al*., 1994). The crop can be used for producing industrial materials, such as oil-cakes and fertilizer. Extracted oil from the kernel is used as culinary oil and other crop extracts are used as animal feeds (Nigam & Lenné, 1996). Almost every part of the crop is used in some way. The multiple uses of the groundnut plant make it an important food and cash crop for domestic consumption and export in many developing and

developed countries. Globally, 50% of total groundnut production is used for oil extraction, 37% for confectionery use and 12% for seed (Taru *et al*., 2010).Groundnut is grown in nearly 100 countries. Globally, it is grown on almost 23.95 million hectares with total production of 36.45 million tons and an average yield of 1,520 kg/acre in 2009 (FAOSTAT, 2011). China, India, Indonesia, Nigeria, Senegal, Sudan, USA and Myanmar are the major groundnut growing countries (Taru *et al*., 2010; FAOSTAT, 2011).

2.2. Propolis (Bee glue)

Propolis is a wax –like resinous substance collected by honey bees from tree buds or other botanical sources and used as cement to seal cracks and open spaces in the hive, its color varies from green to brown and reddish, depending on its botanical source.

Honey bees use Propolis to seal gap inside the hive that smaller than 3/16 or 1/4 (5mm or 6mm) while they leave themselves a bee space approximately 9.5mm or 38 larger spaces being filled with wax cone (Burdock, 1998).

2.2.1. Uses

Reinforce the structural stability of the hive.

Reduce vibration.

Make the hive more defensible by sealing alternate entrances.

Bees may also use it to prevent infection with disease and parasites in the hive.

2.2.2. Composition

The composition of Propolis varies from hive to hive, district and from season to season. Occasionally, bees gather calking compounds of human manufacture. Even propolis samples taken from a single colony can vary,

making controlled clinical tcsts virtually impossible (Banskota *et al*, 2001 and Bankova, 2005).

The source of Propolis varies with the latitude. In temperate regions bees collect resins from trees, mostly poplars and to a lesser extent conifer the biological roles of propolis in trees is seal wounds and defend against bacteria, fungi and insects. In tropical regions, bees gather propolis from flowers, especially clusia, that have adapted propolis and tropical are different. Poplar propolis is rich in flavanoids. Clusia propolis contains polyprenylated benzophenones. Typical propolis has approximately 50 costituents, primarily resins and vegetable balsams (50%) waxes (30%), essential oils (10%) and pollea (5%) . Propolis is sticky at and above room temperature. At lower temperature it becomes hard and very brittle (Burdock, 1998).

2.2.3. Physical characteristics

The colour of propolis ranges drom yellow to dark brown depending on the origin of the resins. But, even transparent propolis has deported. At 25 to 45 c propolis is a soft, pliable and very sticky substance. At less than 15 c , and particularly when frozen or at near freezing it becomes hard and brittle .It remains brittle after such treatment even at higher temperature Above 45 c ., it becomes increasingly sticky and gaminy. Typically, propolis becomes liquid at 60 to 70 C^o but for some samples the melting point may be as high as 100 C^o. The most common solvents used for commercial extraction are ethanol (ethylalcohol) ether, giycol and water for chemical analysis a large variety of solvents may be used in other to extract the various fractions many of the bactericidal components are soluble in water or alcohol (Arvouet *et. al* ,1993).

2.2.4. Chemical characteristics

The composition of propolis varies with its geographic and plant source, as well as with the collection season (Banskota, *et ,al*,2001 and Bankova , 2005)

.The alcohol extract of Propolis is called propolis wax or tincture, with the insoluble residue known as propolis resin (Burdock, 1998) propolis contains 50% resin and vegetable balsam 30% wax and aromatic oils, 5% pollen, and 5% other substance including minerals such as magnesium, nickel, iron, calcium, and zinc (Burdock ,1998 and Castaldo and Capasso, 2002).

Propolis contains flavonoids such as quereetin, pinoeembrin galangin, and pinobanksin, as well as hydroquinone, caffeic acid esters(Burdock ,1998 and Castaldo and Capasso, 2002).

A number of other compounds have been identified in propolis from specific geographic source (Popova *et. al.*, 2005).

2.2.5. Antimicrobial effects:

Preliminary scientific studies show some types of propolis have *in vitro* antibacterial (Orsi,*et.al*,2005) and antifungal(Cafarchia,*et.al*,1999) activity with active constituents including flavonoids like galangin (Cushnie and Lamb 2005)and hydroxycinnamic acids like caffeic acid. (Qiao and Chen 1991) In the absence of any *in vivo* or clinical studies however, it is not clear if this antimicrobial activity has any therapeutic relevance.

2.2.6. Acaricidal effect:

A number of researchers have reported insecticidal effect of bee propolis. Solvent extracts of propolis samples from Brazil and Bulgaria exhibited leishmanicidal activity against different species of *Leishmania* (Gerzia *et. al*., 2007). In Nigeria, Osipitan *et. al*., (2010) tested propolis ethanolic extracts against the larger grain borer, *Prostephanus truncates* (Horn) in maize grains. A reduction of the borer population in maize was observed. Interestingly, pesticides commonly used in agriculture were detected in honey and propolis samples (Lucia *et al,* 2011) in Uruguay.

Recently bee propolis extracts have been reported to have acaricidal effect on red spider mites (*Tetranychus spp*.), which attack tomatoes, (Kareru and Wamaitha, 2012, unpublished work).

Compounds present in propolis can provide potential alternative in the place of currently used insect pest control agents because they constitute a rich source of bioactive chemicals and may act in many way on various types of pest complex. They also have no or little harmful effects on non target organisms such as pollinators, natural enemies and are biodegradable.

Both ethanolic and ethyl acetate extracts of bee propolis acted on red spider mites in a concentration and time dependent manner. The activity of ethanolic extracts at concentrations of 75 and 100 mg/ml was not significantly different with that of the positive control used.

Ethanolic and ethyl acetate extracts acted on tomato red spider mites in a concentration and time dependent manner, and had no significant differences in activity.

Bee propolis extracts could thus be used as a safe insecticide in the control of red spider mites. However, further researches are needed to be done on its potential on other life stages of red spider mites and other common tomato pests. The insecticidal activity was thought to be due to bioactive phytochemicals of plant origin ingested by the bees during pollination.

2.3. Potassium Nitrate

Potassium nitrate (KNO_3) is a soluble source of two major essential plant nutrients. It is commonly used as a fertilizer for high-value crops that benefit from nitrate (NO_3^-) nutrition and a source of potassium (K^+) free of chloride (Cl^-) (Khalifa, *et al*., 2009).

2.3.1. Production

Potassium nitrate fertilizer (sometimes referred to as nitrate of potash or NOP) is typically made by reacting potassium.

Chloride (KCl) with a nitrate source, Depending on the objectives and available resources, the nitrate may come from sodium nitrate, nitric acid, or ammonium nitrate, The resulting KNO_3 is identical regardless of the manufacturing process, Potassium nitrate is commonly sold as a water-soluble, crystalline material primarily intended for dissolving and application with water or in a prilled form for soil application. Traditionally, this compound is known as saltpeter.

2.3.2. Chemical Properties

Chemical: formula:	KNO_3
N content:	13%
K_2O content:	44/46%
Water solubility (20°C)	316 g/L
Solution pH	7 to 10

2.3.3. Agricultural use

The use of KNO_3 is especially desirable in conditions where a highly soluble, chloride-free nutrient source is needed.

The entire N is immediately available for plant uptake as nitrate, requiring no additional microbial action and transformation in the soil. Growers of high value vegetable and orchard crops sometime prefer to use a nitrate-based source of nutrition in an effort to boost yield and quality. Potassium nitrate contains a relatively high proportion of K, with a N to K ratio of approximately 1:3. Many crops have high K demands and can remove as much or more K than N at harvest (Khalifa, *et al.*, 2009).

Applications of KNO_3 to the soil are made before the growing season or as a supplement during the growing season. A diluted solution is sometimes sprayed on plant foliage to stimulate physiological processes or to overcome nutrient deficiencies. Foliar application of K during fruit development can be advantageous for some crops, since this growth stage often coincides with high K demands during the time of declining root activity and nutrient uptake. It is also commonly used for greenhouse Plant production and hydroponic culture.

2.3.4. Management Practices

Both N and K are required by plants to support harvest quality, protein formation, disease resistance, and water use efficiency. Therefore, KNO_3 is often applied to soil or through the irrigation system during the growing season to support healthy growth.

Potassium nitrate accounts for only a small portion of the global K fertilizer market. It is primarily used where its unique composition and properties are able to provide specific benefits to growers. It is easy to handle and apply, and is compatible with many other fertilizers. This includes usage for many high-value specialty crops, as well as grain and fiber crops.

The relatively high solubility of KNO_3 under warm conditions allows for a more concentrated solution than for other common K fertilizers. Careful water management is needed to keep the nitrate from moving below the root zone.

2.3.5. Non Agricultural uses:

Potassium nitrate has long been used for fireworks and gunpowder. It is now more commonly used in food to maintain the quality of meat and cheese. Specialty toothpastes often contain KNO_3 to alleviate tooth sensitivity. A mixture of KNO_3 and sodium nitrate ($NaNO_3$) is used for storing heat in solar energy installations. (www.ipni.net)

CHAPTER THREE

MATERIALS AND METHODS

3.1. Study site:

This study comprises of laboratory and small scale nursery experiments. Laboratory experiment was conducted at College of Agricultural Studies, SUST. The nursery experiment was undertaken same site during June - November 2016. The objective of this experiment is to study the effect of the Propolis, potassium nitrate and their mixture on seed germination and some growth parameters of groundnut (*A. hypogaea*).

3.2. Laboratory experiment

3.2.1. Treatments preparation

An amount of five grams of Propolis powder was dissolved in 2 ml of liquid soap then macerated in 500 ml of distilled water. The obtained solution was used as stock concentration. Sub-concentrations were made as 5, 10 and 15 %. To prepare potassium nitrate solution, the same amount was macerated in 500 ml of distilled water and then similar concentrations were made. A mixture of 50% of stock concentration of Propolis powder and potassium nitrate was also prepared of which three concentrations were done.

3.2.2. Laboratory work

The experiment was consisted of nine treatments (concentrations) in addition to the untreated control. All treatments were arranged in a complete randomize design replicated three times. For each treatment, a filter paper was placed in a Petri-dish (Replication). An amount of 5 ml of each treatment was added to each of the three Petri-dish assigned for it. The control was treated with distilled water only. Five sound kernels of groundnut were placed in each treated Petri-dish immediately after application (Plate: 1).

The experiment was carried out under room temperature (37±2 °C). The germination percentage was recorded daily for 3 days from inoculation for each treatment.

3.3. Nursery work

This experiment was conducted during June –July 2016. The soil used in this experiment was clay soil where sand fraction amounts to more than 88%. The organic matter, nitrogen and phosphorus are very low.

3.3.1. Sowing

The successful grown kernels of each treatment from the laboratory work were collected in a Petri-dish. Collected kernels were used for conducting the nursery experiment. Three kernels from each treatment were sown in a plastic pot filled with 10 kg of clay soil. The experimental design adopted was a complete randomized design (CRD) with three replications. The experimental unit (pot) consisted of three plants. The kernels were watered on base of three days interval throughout the study. The plant length, number of leaves and number of branches were taken every 10 days. At the end of the study yield, fruit numbers, fresh and dry weight of the shoot system were recorded (Plates 2-5).

3.4. Statistical analysis

Data for germination percentage, growth parameters were transformed using Arcsine or $\sqrt{X+0.5}$ when needed. The data were subjected to analysis of variance (ANVOA). Duncan's Multiple Range Test (DMRT) was used for means separation. Analysis was done using Mstat-C statistical package.

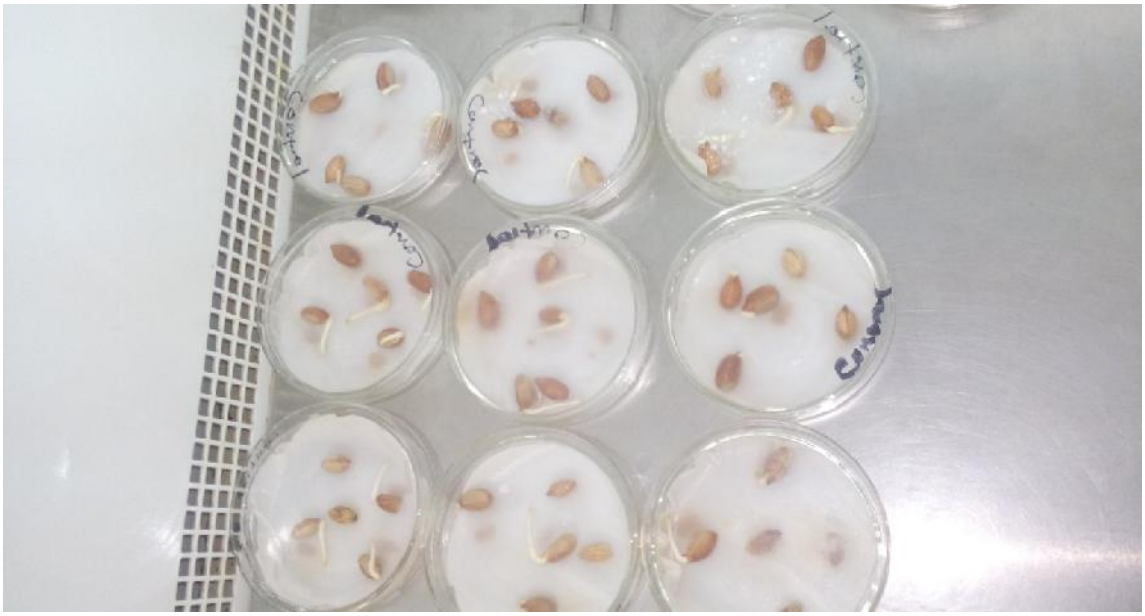

Plate 1: Laboratory work

Plate 2: Layout of treatment in nursery

Plate 3: Propels treatment

Plate 4: Potassium nitrate (KNO3) treatment

Plate 5: Mixture of Propolis+KNO3 treatment

Plate 6: Laboratory work Control (Un treated)

CHAPTER FOUR

RESULTS

4.1. Effect of Propolis, potassium nitrate and their mixture on germination of groundnut seed under laboratory conditions.

Results in table (1) and figure (1) showed that all tested part per million of Propolis, Potassium nitrate and their mixture affect positively the seed germination when compare with untreated control. After 24 hours of application no germination was observed in all treatment includes untreated control. After two days of treatment the highest concentration of Propolis (15%) gave the highest germination percentage (80%) followed by the medium concentration of Propolis (73.3%), while the least germination percentage recorded by untreated control (6.7%). Result after 3 days of treatment revealed that the Propolis at all tested concentration and the mixture of Propolis and KNO_3at all concentration gave non significant difference on seed germination, while the control gave the least germination percentage which was 6.7%.

Table 1. Effect of Propolis, potassium nitrate and their mixture on germination of groundnut Seed under laboratory conditions

Treatments	**Rate (g/100 of water)**	**Seed germination (%)**	
		After 48 hours	**After 72 hours**
Propolis powder	5	60.00 (51.14) abc	66.67 (60.0) a
Propolis powder	10	73.33 (63.85) ab	73.33 (63.82) a
Propolis powder	15	80.00 (68.0) a	80.00 (68.07) a
Potassium nitrate (KNO_3)	5	26.67 (25.78) cd	33.33 (35.01) bc
Potassium nitrate (KNO_3)	10	33.33 (30.00) bcd	40.00 (38.86) ab
Potassium nitrate (KNO_3)	15	40.00 (38.76) abcd	40.00 (38.86) ab
Mixture of Propolis+ KNO_3	2.5+2.5	40.00 (38.86) abcd	60.00 (51.14) a
Mixture of Propolis+ KNO_3	5+5	46.67 (43.08) abc	60.00 (51.14) a
Mixture of Propolis+ KNO_3	7.5+7.5	60.00 (51.17) abc	66.67 (59.92) a
Control (Un treated)	-	6.67 (8.86) d	6.67 (8.86) b
C.V (%)	-	42.20%	39.43%
SE±	-	4.1	4.2

- Figures between brackets were transformed to arcsine.

- Values in the same column with same letter (s) are not significant at 0.05%.

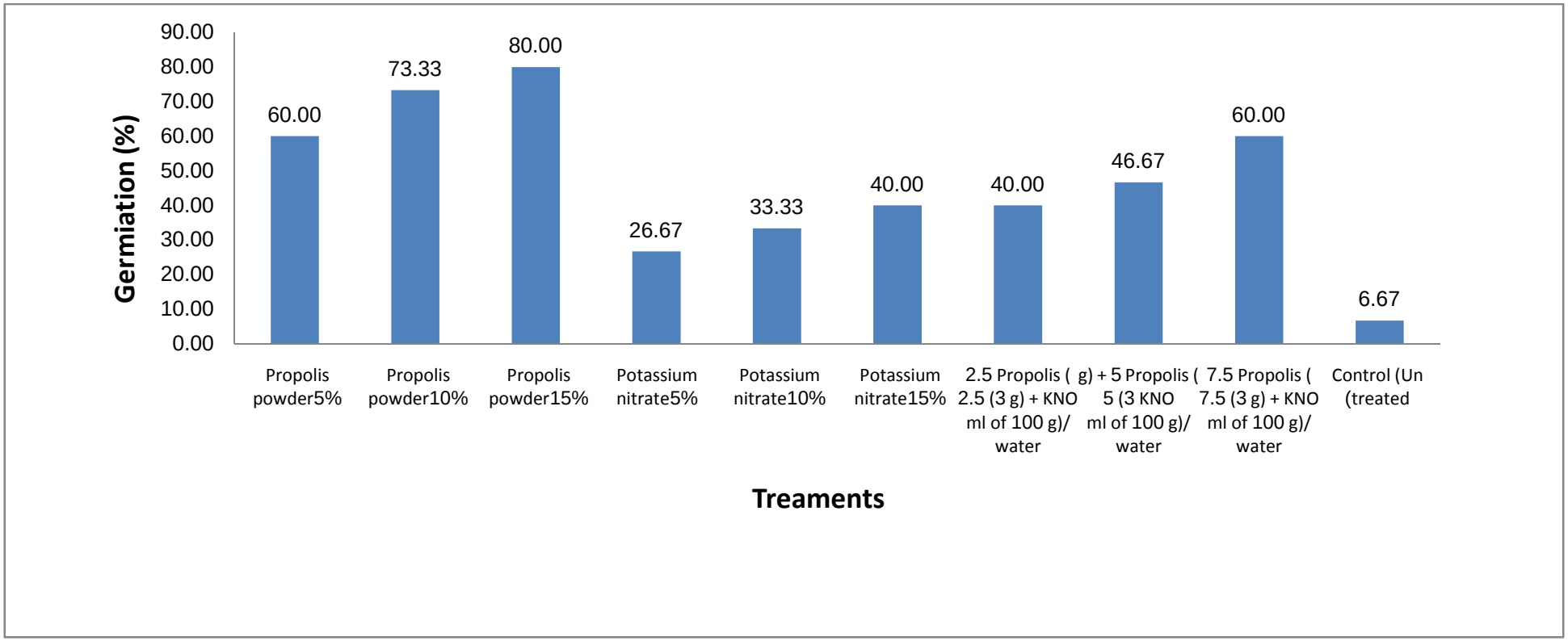

Figure 1. Effect of Propolis, potassium nitrate and their mixture on germination of groundnut Seed under laboratory conditions after 48 hours.

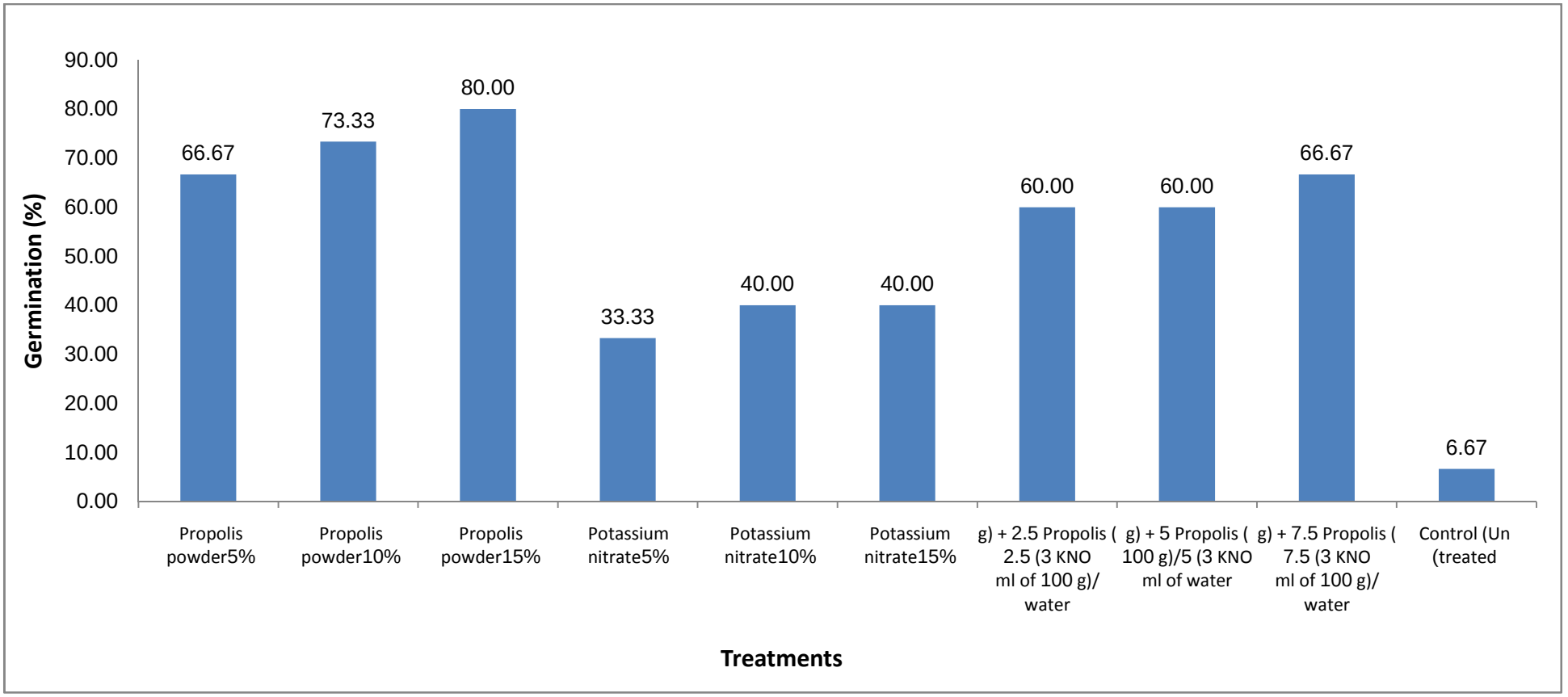

Figure 2. Effect of Propolis, potassium nitrate and their mixture on germination of groundnut seed under laboratory conditions after 72 hours.

4.2. Effect of Propolis, potassium nitrate and their mixture on number of leaves of groundnut plants under nursery conditions.

Throughout the study all tested concentration of Propolis, $KNO_3$and their mixture showed positive effects on the mean of number of leaves three plants compare to untreated control. Ten days after treatment the Propolis at all tested concentration and the highest and medium concentration of mixture recorded non significant highest number of leave, while the control recorded the least mean number of leaves which was 0.89 leave per plant. After Twenty days of treatment the highest mean number of leaves per plant gave by the Propolis at (15%) followed by all treatment except the untreated control which gave the least number mean number of leaves (14) leaves per three plant table (2) and figure (4). After 30 days of treatment the highest mean number of leaves was recorded by the Propolis in their highest and medium concentration followed by the rest of treatments except the untreated control which was recorded the lowest mean number mean number of leaves (2.3) table (2) and figure (5).

Table 2. Effect of Propolis, potassium nitrate and their mixture on number of leaves of groundnut plants under nursery conditions.

Treatments	**Rate (w/v)**	**Number of leaves**		
		After 10 days	**After 20 days**	**After 30days**
Propolis powder	5	2.41 (1.70) a	31.39 (5.61) ab	48.00 (6.76) ab
Propolis powder	10	2.67 (1.76) a	33.78 (5.79) ab	51.75 (7.22) a
Propolis powder	15	2.78 (1.81) a	38.33 (6.22) a	54.44 (7.33) a
Potassium nitrate (KNO_3	5	1.78 (1.49) ab	24.00 (4.92) ab	24.22 (4.85) ab
Potassium nitrate (KNO_3	10	2.00 (1.57) ab	22.00 (4.74) ab	38.00 (6.17) ab
Potassium nitrate (KNO_3)	15	2.11 (1.58) ab	30.61 (5.37) ab	38.33 (6.22) ab
Mixture of Propolis+ KNO_3	2.5+2.5	2.11 (1.59) ab	28.97 (5.42) ab	44.44 (6.33) ab
Mixture of Propolis+ KNO_3	5+5	2.33 (1.68) a	29.56 (5.47) ab	42.57 (6.53) ab
Mixture of Propolis+ KNO_3	7.5+7.5	2.67 (1.76) a	30.78 (5.45) ab	46.94 (6.58) ab
Control (Un treated)	-	0.89 (1.17) b	14.00 (3.98) b	20.33 (4.55) b
C.V (%)	-	16.0%	17.8%	21.3%
SE±	-	0.05	0.18	0.26

- Figures between brackets were transformed to √X+0.5
- Figures in the same column with same letter (s) are not significant at 0.05%.

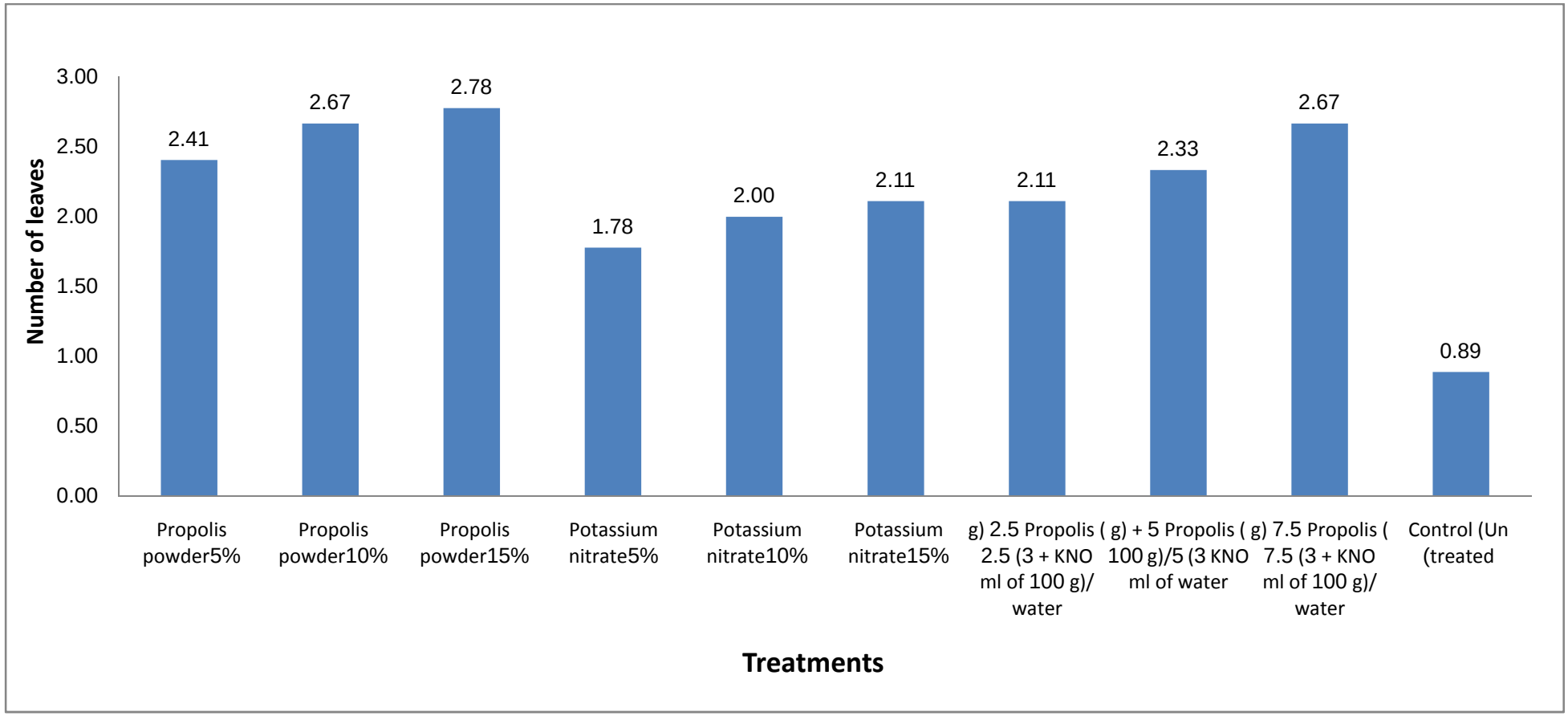

Figure 3. Effect of Propolis, potassium nitrate and their mixture on number of leaves of groundnut plants under nursery conditions after ten days.

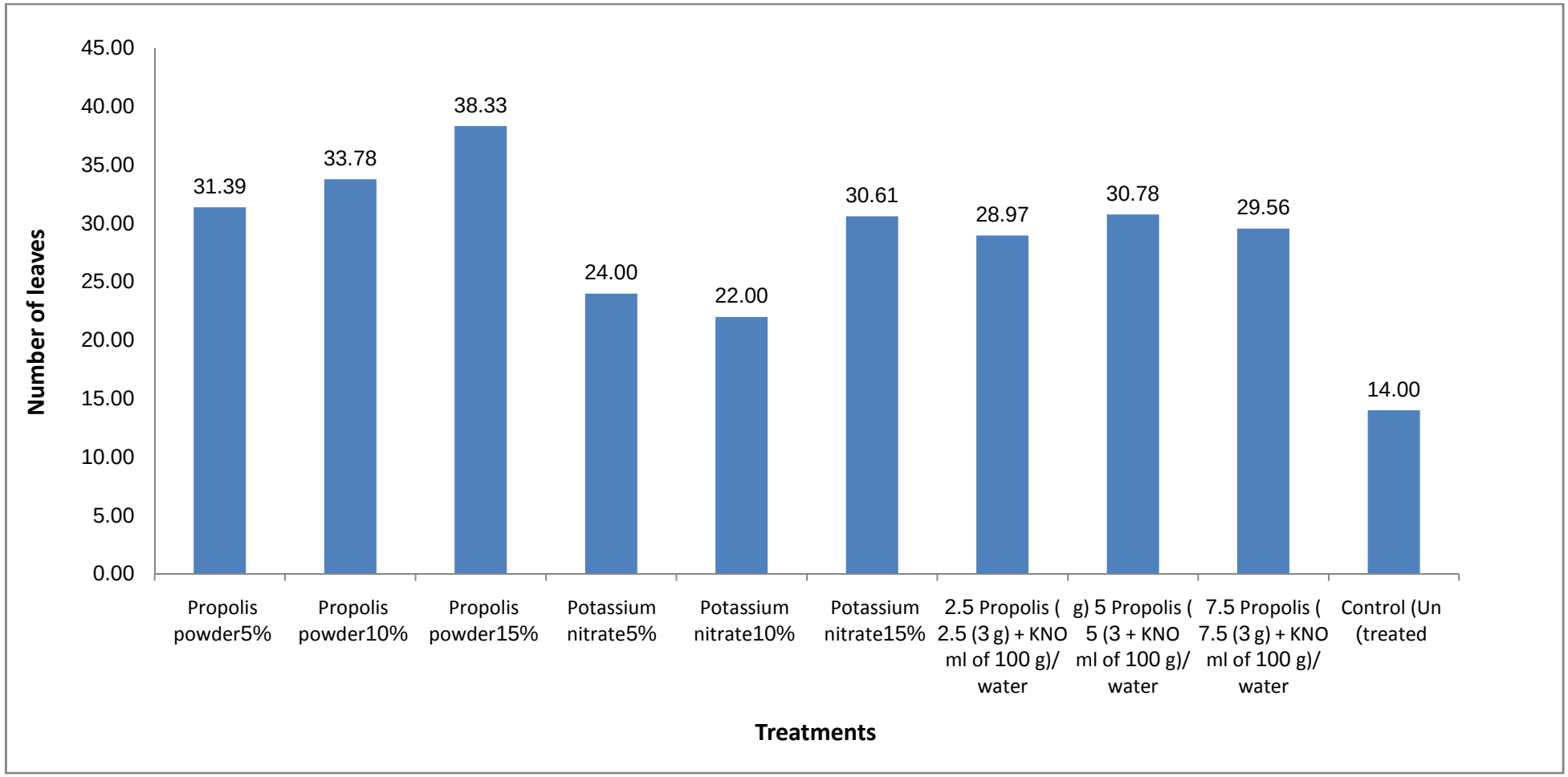

Figure 4. Effect of Propolis, potassium nitrate and their mixture on number of leaves of groundnut plants under nursery conditions after 20 days.

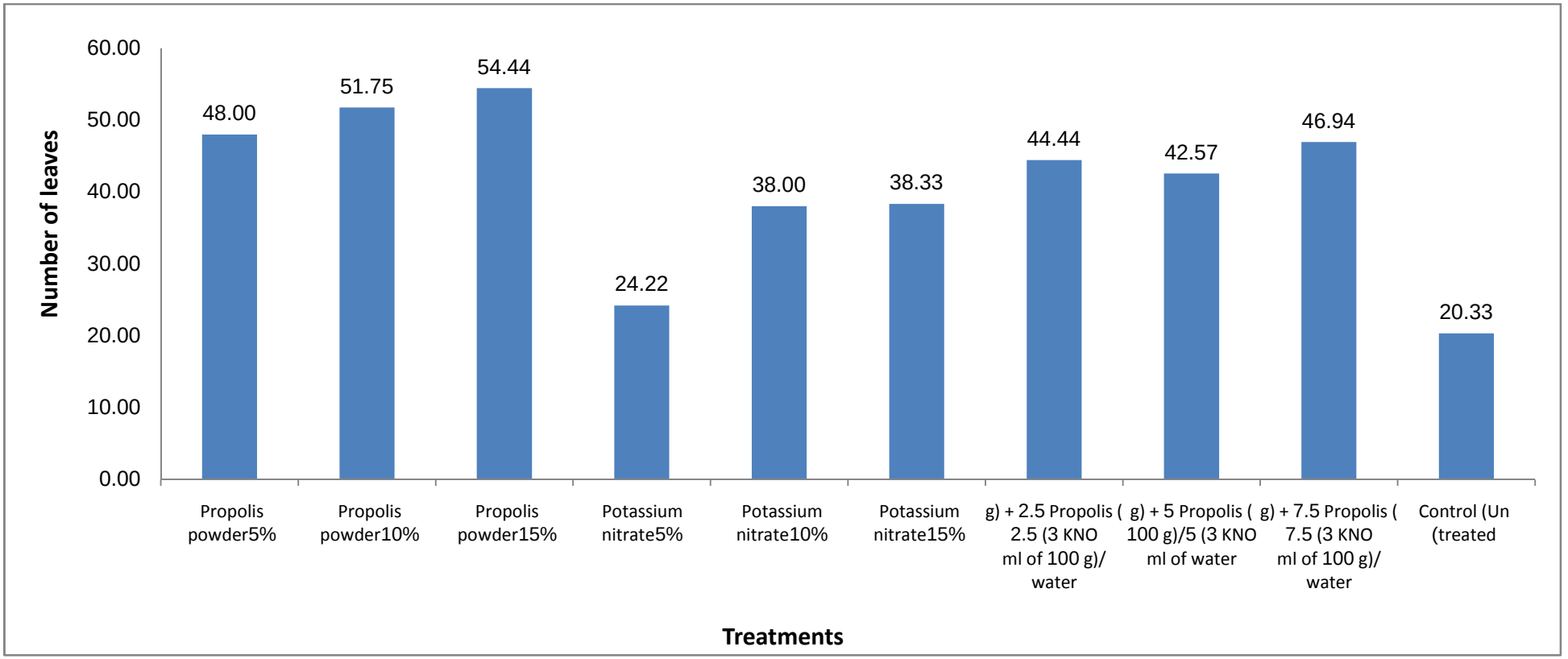

Figure 5. Effect of Propolis, potassium nitrate and their mixture on number of leaves of groundnut plants under nursery conditions after 30 days.

4.3. Effect of Propolis, potassium nitrate and their mixture on the plant height of groundnut under nursery conditions.

The results appear in table (3) and figure (6) showed that after ten days of application the highest mean plant height recorded by Propolis in all concentration and the highest concentration of mixture, while the least mean plant height was recorded by untreated control (3.5cm). After 20 days of application all tested treatments as well as untreated control gave non similar non significant mean plant height table (3) and figure (7). Similar trend of results was noted after 3 days of treatments table (3) and figure (8).

Table 3. Effect of Propolis, potassium nitrate and their mixture on the plant height of groundnut under nursery conditions.

Treatment	Rate (w/V)	Plant hight		
		After 10 days	After 20 days	After 30days
Propolis powder	5	7.33(2.80) a	12.15(3.55) a	51.33 (7.10) a
Propolis powder	10	7.50 (2.83) a	13.27(3.69) a	55.83 (7.43) a
Propolis powder	15	8.33 (2.94) a	14.27(3.84) a	56.22 (7.87) a
Potassium nitrate (KNO_3)	5	5.00(2.32) ab	9.80 (3.17) a	30.50 (5.52) a
Potassium nitrate (KNO_3)	10	5.70(2.43) ab	11.00(3.19) a	41.00 (6.35) a
Potassium nitrate (KNO_3)	15	6.00(2.53) ab	12.00(3.32) a	40.50 (6.38) a
Mixture of Propolis+ KNO_3	2.5+2.5	6.67(2.65) ab	10.57(3.32) a	47.33 (6.65) a
Mixture of Propolis+ KNO_3	5+5	7.00(2.74) ab	11.53(3.34) a	47.27 (6.89) a
Mixture of Propolis+ KNO_3	7.5+7.5	8.20(2.94) a	13.07(3.38) a	49.67 (6.96) a
Control (Un treated)	-	3.50(1.98) b	7.03(2.70) a	28.67 (5.37) a
C.V (%)	-	15.3%	17.7%	20.2%
SE±	-	0.08	0.11	0.25

Figures between brackets were transformed to √X+0.5

Figures in the same column with same letter (s) are not significant at 0.05%.

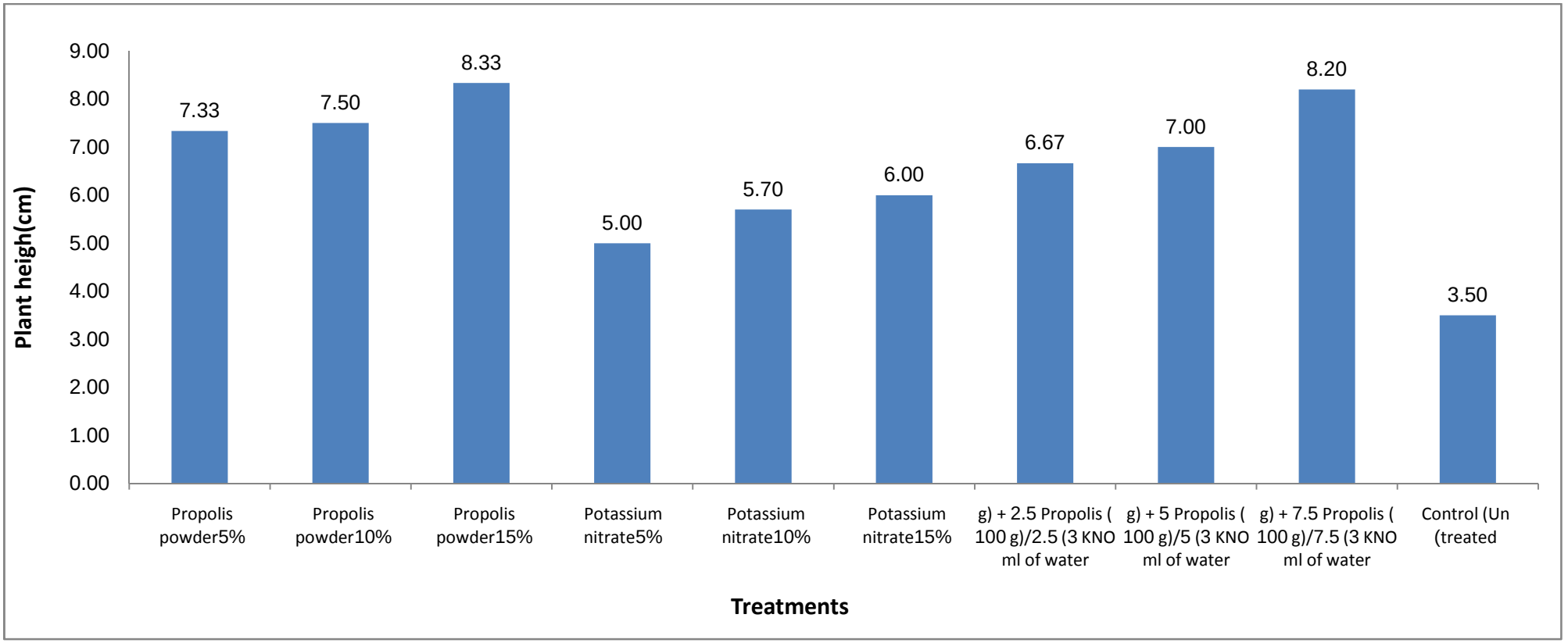

Figure 6. Effect of Propolis, potassium nitrate and their mixture on the plant height of groundnut under nursery conditions after 10 days.

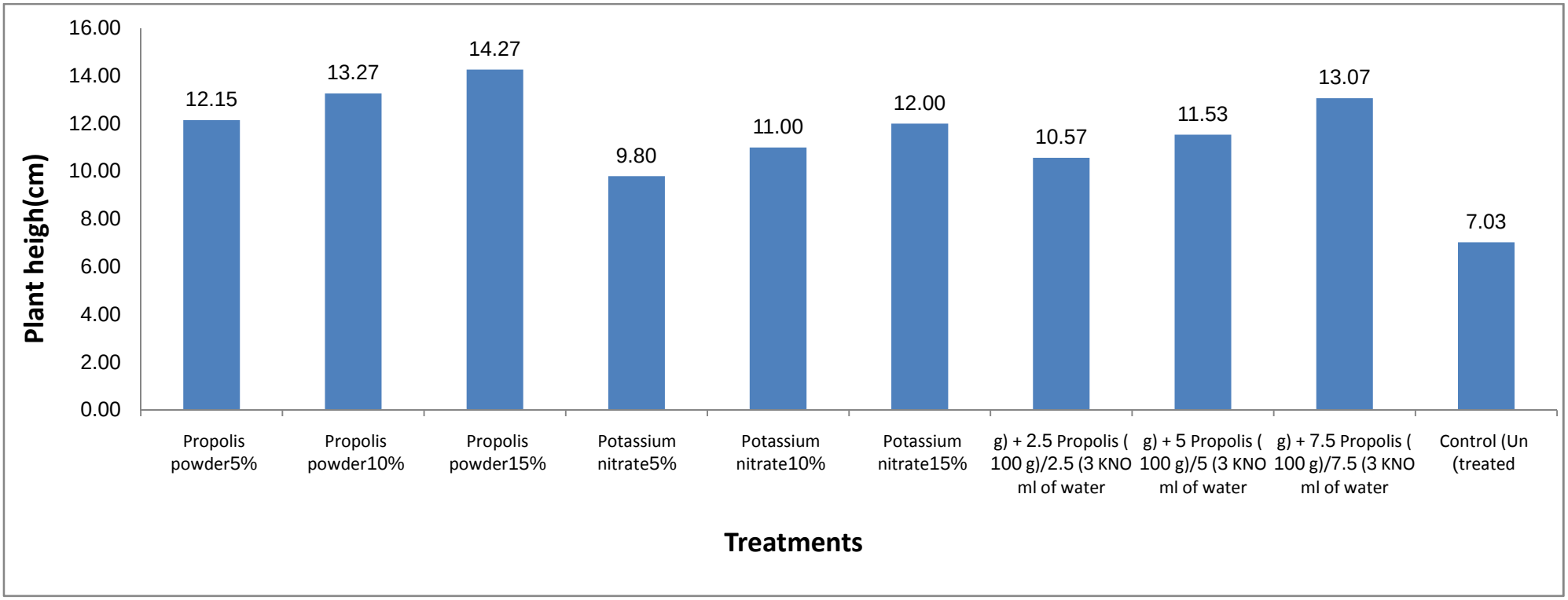

Figure 7. Effect of Propolis, potassium nitrate and their mixture on the plant height of groundnut under nursery conditions after 20 days.

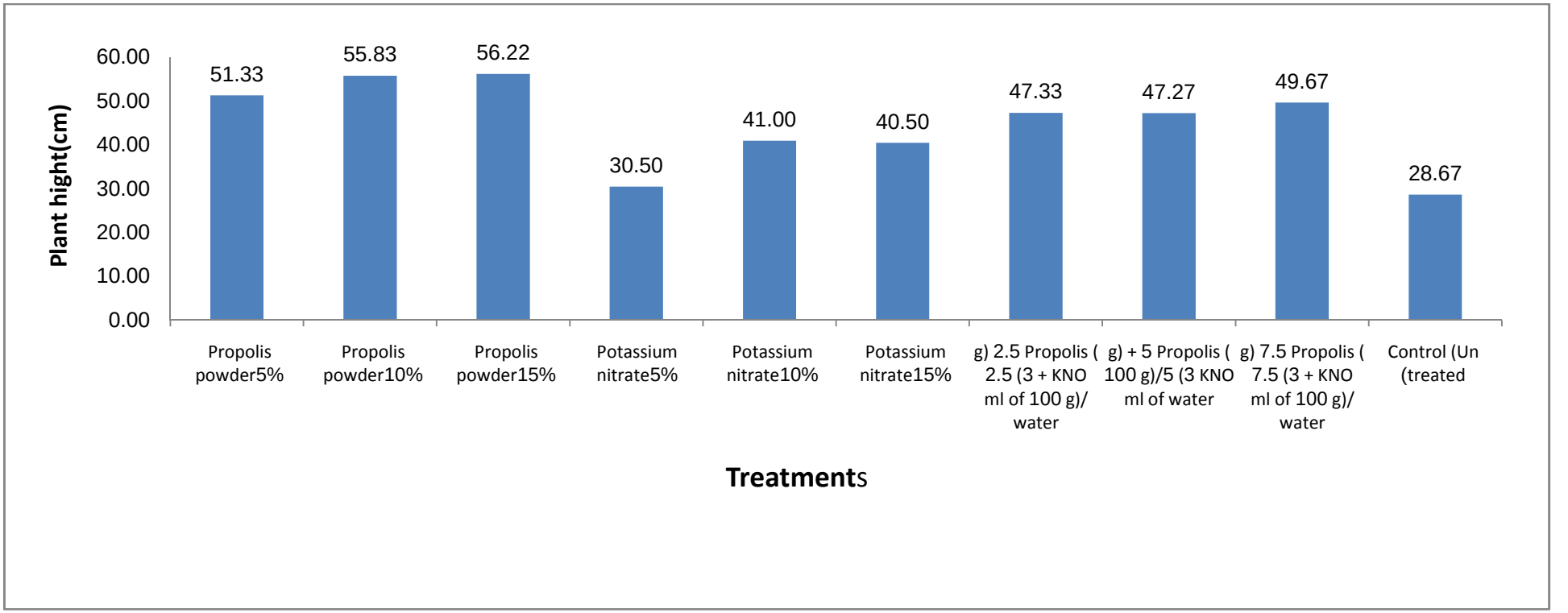

Figure 8. Effect of Propolis, potassium nitrate and their mixture on the plant height of groundnut under nursery conditions after 30 days.

4.4. Effect of Propolis, potassium nitrate and their mixture on the fresh and dry weight of groundnut planted under nursery conditions.

For the groundnut pod the highest fresh weight gave by the Propolis in all concentration, while the least fresh weight of pod was recorded by the untreated control. Similar trends of results notes in the case of dry weight of pod table (4) figure (9).

Regarding the shoot of ground nut plant the highest mean of fresh weight reported by the Propolis by the highest concentration of Propolis followed by the medium and lower concentration of Propolis, while the untreated control reported the lowest mean of shoot weight which was 98.2 gram table (4) figure (10). For the dry weight of shoot the Propolis at highest concentration gave the highest dry weight (19.43 gram) followed by the Propolis in the medium and lower concentration. The lowest mean dry weight of shoot was reported by untreated control (23.7 grams) (Table 4 and Fig10).

Table 4. Effect of Propolis, potassium nitrate and their mixture on the fresh and dry weight of groundnut planted under nursery conditions.

Treatments	**Rate (w/V)**	**Weight (g)**			
		Pod		**shoot**	
		Fresh	**Dry**	**Fresh**	**Dry**
Propolis powder	5	116.7 (10.99) c	42.2 (6.53) c	230.5 (15.20) c	156 (12.51) c
Propolis powder	10	131 (11.63) b	56.5 (7.55) b	257.4(16.06) b	159.9(12.67) c
Propolis powder	15	217 (14.91) a	142.5(11.96) a	451.4 (21.27) a	376.9(19.43) a
Potassium nitrate (KNO_3)	5	87.6 (9.55) ef	13.1 (3.68) g	189.6 (13.79) e	65.5 (8.12) f
Potassium nitrate (KNO_3)	10	89.8 (9.66) ef	15.3 (3.98) g	140 (11.85) f	115.2(10.76) e
Potassium nitrate (KNO_3)	15	93.7 (9.72) ef	19.2 (4.43) f	189.7 (13.79) e	115.1(10.75) e
Mixture of Propolis+KNO_3	2.5+2.5	96.3 (9.99) de	21.8 (4.72) f	189.9 (13.80) e	115.4(10.76) e
Mixture of Propolis+KNO_3	5+5	104.8(10.42) cd	30.3 (5.55) e	212.6(14.60) d	138.1(11.77) d
Mixture of Propolis+KNO_3	7.5+7.5	107 (10.53) cd	32.5 (6.08) d	234.4 (15.33) c	182.9(13.54) b
Control (Un treated)	-	81.6 (9.22) f	7.1 (2.75) h	98.2 (9.93) g	23.7 (4.917) g
C.V (%)	-	3.1%	4.3%	0.8%	1.6%
SE±	-	0.30	0.46	0.52	0.66

Figures between brackets were transformed to √X+0.5

Figures in the same column with same letter (s) are not significant at 0.05%.

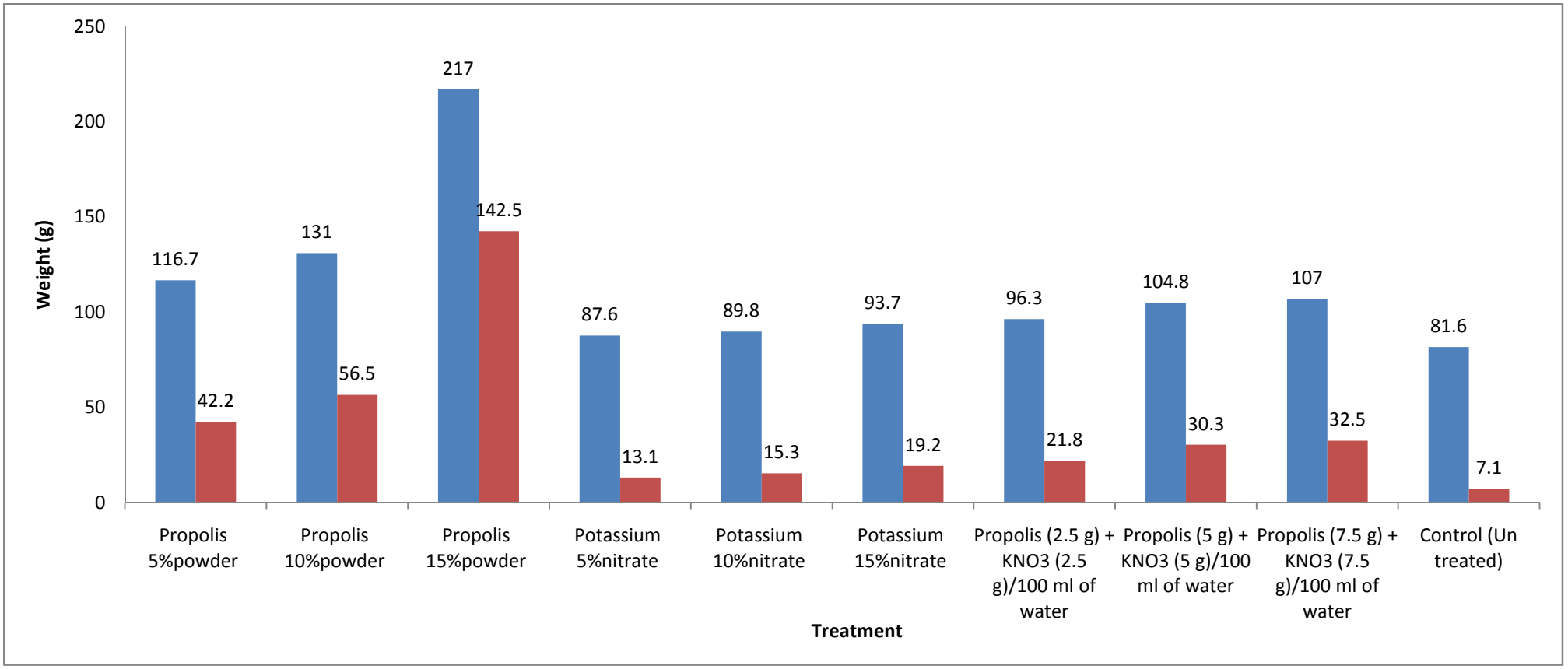

Figure 9. Effect of Propolis, potassium nitrate and their mixture on the fresh and dry weight of groundnut pods planted under nursery conditions.

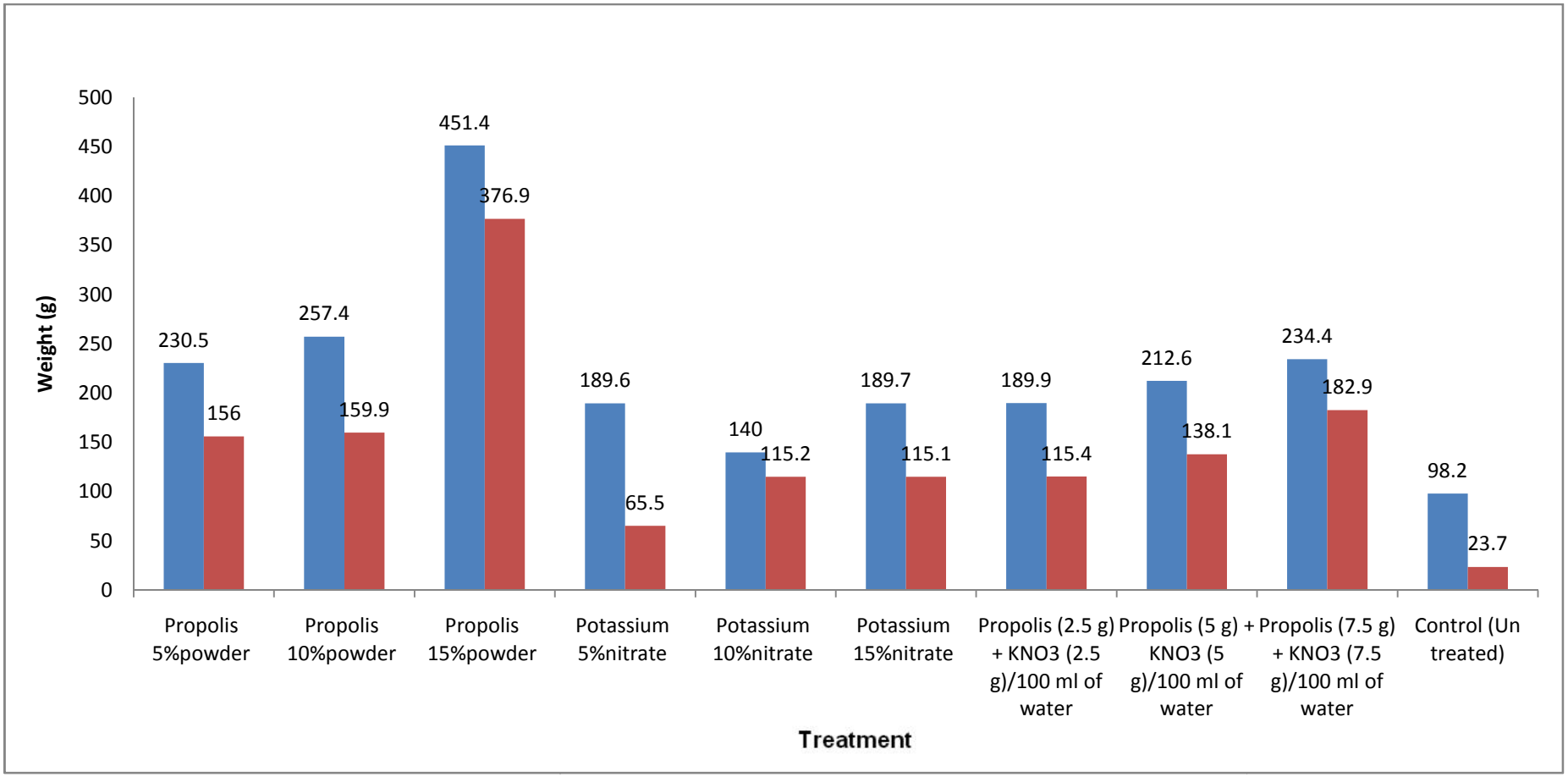

Figure 10. Effect of Propolis, potassium nitrate and their mixture on the fresh and dry weight of shoot planted under nursery conditions.

CHAPTER FIVE

DISCUSSION

Groundnut is an important cash crop in Sudan use for producing oil. It is widely grown in both rain-fed (85%) and irrigated (15%) sectors Weiss, (1983). In the last two decades, more attention has been given on application of non chemical materials in different formulation as pests control agents and enhancing plant growth hormones (Idris *et al*., 2011). Tillage operation and seed treatment are conducted in order to create a suitable and healthy seedbed. Mardi (2013) reported that in sandy soil in western Sudan groundnut seed faces some limiting factor affecting germination such as fungal infection, genetic factor associated with cultivars. The results presented in this study showed that all tested concentrations of Propolis, Potassium nitrate and their mixture had a positive effect on seed germination, number of leaves, plant height and the dry and fresh weight of groundnut pod and shoot in compare with untreated control. To my knowledge no literature cited on the test of Propolis (bee honey product) as plant activator or fertilizer. Among treatments and after 3 days of inoculation, results revealed that there is no significant difference in the highest seed germination, while the control gave the least germination percentage which was 6.7%. Burdock (1998) stated that Propolis had some benefits for bee honey colonies such as sterilizing against antimicrobial infections and providing healthy conditions for a whole bee honey colonies. Mardi (2013) stated that to obtain high germination of groundnut seeds a suitable seed dresser must be used to provide healthy conditions around the seed. In this study the high germination of groundnut seeds treated with Propolis may due to positive antimicrobial effect on harmful seed borne microorganisms. Also, Propolis may be consisting of some ingredients which may be activated or enhanced the biochemical processes associated with the seed germinations. Capasso (2002) reported that

Propolis containing some minerals such as magnesium, nickel, iron, calcium, and zinc which they are occurs in free and absorbable conditions. According by the high mean number of leaves that was recorded by the Propolis in their highest and medium concentrations could be attributed to growth promoting effect of these minerals. This could explain also the plant height and dry and fresh weight of groundnut pod and shoot, where Propolis showed positive significant effects as expressed in increased number of leaves.

5.1 Conclusions

1. All tested concentrations of Bee glue (Propolis) powder aqueous extract and their mixture with potassium nitrate had a positive effects on seed germination, number of leaves, plant height and the dry and fresh weight of groundnut pod and shoot compared with untreated control.
2. Bee glue (Propolis) powder aqueous extract at all tested concentration and their mixtures gave the highest seed germination.
3. The highest mean number of leaves was recorded by the Propolis in their highest and medium concentrations.
4. All tested concentrations of Bee glue (Propolis) powder aqueous extract, potassium nitrate and their mixture as well as untreated control showed no effect on mean plant height.
5. For the groundnut pod and shoot the highest fresh and dry weight was given by the Bee glue (Propolis) powder aqueous extract at all tested concentrations.

5.2 Recommendations

The effect of bee glue (Propolis) powder aqueous extract compounds as seed dresser in order to enhance groundnut seed germination and general plant health. Following recommendations are of importance to further investigate

1- Evaluate doses higher than tested one might give higher germination percentage.
2- In corporate this honey bee excaudate in trials as alternative to chemical seed dresser to safe environment, seeds and microbial community of the soil.
3- More studies are highly encouraged for confirmation.

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Web sites:

(www.ipni.net)

APPENDICES

Appendix 1. Germination after 48 hours

Treatment	R1	R2	R3
Propolis 5%	4	2	3
Propolis 10%	3	3	5
Propolis 15%	4	5	3
Potassium nitrate (KNO_3) 5%	0	1	3
Potassium nitrate (KNO_3) 10%	0	2	3
Potassium nitrate (KNO_3) 15%	1	3	2
Propolis (2.5%) + KNO_3 (2.5%)	2	3	1
Propolis (5%) + KNO_3 (5%)	2	2	3
Propolis (7.5%) + KNO_3 (7.5%)	2	4	3
Control (Un treated)	0	0	1

Germination after 72 hours

Treatment	R1	R2	R3
Propolis 5%	1	4	5
Propolis 10%	3	3	5
Propolis 15%	4	5	3
Potassium nitrate (KNO_3) 5%	1	2	2
Potassium nitrate (KNO_3) 10%	1	2	3
Potassium nitrate (KNO_3) 15%	2	3	1
Propolis (2.5%) + KNO_3 (2.5%)	4	2	3
Propolis (5%) + KNO_3 (5%)	2	4	3
Propolis (7.5%) + KNO_3 (7.5%)	2	3	5
Control (Un treated)	0	0	1

Data file: LAB
Title: Germination
Function: ANOVA-1
Data case no. 1 to 30
One way ANOVA grouped over variable 2 (trt)
With values from 1 to 10.
Variable 3 (48hours)

A N A L Y S I S O F V A R I A N C E T A B L E

	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Prob.
Treatment	9	8554.821	950.536	3.032	0.0186
Within	20	6270.892	313.545		
Total	29	14825.712			

Coefficient of Variation = 42.20%

Var. V A R I A B L E No. 3

2	Number	Sum	Average	SD	SE
10.22	6.66	43.077	129.230	3.00	1
10.22	22.65	63.847	191.540	3.00	2
10.22	12.06	51.173	153.520	3.00	3
10.22	12.26	38.757	116.270	3.00	4
10.22	12.10	51.143	153.430	3.00	5
10.22	12.10	38.857	116.570	3.00	6
10.22	25.39	25.780	77.340	3.00	7
10.22	26.61	30.000	90.000	3.00	8
10.22	15.34	8.857	26.570	3.00	9
10.22	20.02	68.067	204.200	3.00	10
	Total	30.00	1258.670	41.956	22.61	4.13
	Within			17.71		

Bartlett's test

Chi-square = 5.059
Number of Degrees of Freedom = 9
Approximate significance = 0.829

Germination after 72 hours (3 day)

A N A L Y S I S O F V A R I A N C E T A B L E

	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Prob.
Treatment	9	8475.754	941.750	2.677	0.0319
Within	20	7034.689	351.734		
Total	29	15510.443			

Coefficient of Variation = 39.43%

Var. V A R I A B L E No. 4

2	Number	Sum	Average	SD	SE
10.83	26.70	59.923	179.770	3.00	1
10.83	22.67	63.823	191.470	3.00	2
10.83	12.10	51.143	153.430	3.00	3
10.83	12.10	38.857	116.570	3.00	4
10.83	12.10	51.143	153.430	3.00	5
10.83	12.10	38.857	116.570	3.00	6
10.83	7.31	35.010	105.030	3.00	7
10.83	31.85	60.000	180.000	3.00	8
10.83	15.34	8.857	26.570	3.00	9
10.83	20.02	68.067	204.200	3.00	10
Total	30.00	1427.040	47.568	23.13	4.22
Within			18.75		

Bartlett's test

Chi-square = 5.938
Number of Degrees of Freedom = 9
Approximate significance = 0.746

Data File : LAB

Title: Germination

Case Range : 31 - 40

Variable 3 : 48hours

Function: RANGE

Error Mean Square = 313.5

Error Degrees of Freedom = 20

No. of observations to calculate a mean = 3

Duncan's Multiple Range Test

LSD value = 30.16

s_ = 10.22 at alpha = 0.050

X

Original Order	Ranked Order
Mean (Propolis 5%) → 1 = 51.14 ABC	Mean 3 = 68.0 A
Mean (Propolis 10%) → 2 = 63.85 AB	Mean 2 = 63.85 AB
Mean (Propolis 15%) → 3 = 68.0 A	Mean 9= 51.17 ABC
Mean (Potassium nitrate (KNO_3) 5%) → 4 = 25.78 CD	Mean 1= 51.14 ABC
Mean (Potassium nitrate (KNO_3) 10%) →5 = 30.00 BCD	Mean 8= 43.08 ABC
Mean (Potassium nitrate (KNO_3) 15%) → 6 = 38.76 ABCD	Mean 7= 38.86 ABCD
Mean (Propolis (2.5%) + KNO_3 (2.5%) →7 = 38.86 ABCD	Mean 6= 38.76 ABCD
Mean (Propolis (5%) + KNO_3 (5%) →8 = 43.08 ABC	Mean 5= 30.00 BCD
Mean (Propolis (7.5%) + KNO_3 (7.5%) →9 = 51.17 ABC	Mean 4= 25.78 CD
Mean (Control (Un treated)) →10 = 8.857 D	Mean 10= 8.857 D

Data File: LAB

Title: Germination

Case Range : 31 - 40

Variable 4 : 72hours

Function :

RANGE

Error Mean Square = 351.7

Error Degrees of Freedom = 20

No. of observations to calculate a mean = 3

Duncan's Multiple Range Test

LSD value = 31.94

s_ = 10.83 at alpha = 0.050

x

Original Order	Ranked Order
Mean (Propolis 5%) → 1 = 60.00 A	Mean 3 = 68.07 A
Mean (Propolis 10%) → 2 = 63.82 A	Mean 2= 63.82 A
Mean (Propolis 15%) → 3 = 68.07 A	Mean 1= 60.00 A
Mean (Potassium nitrate (KNO_3) 5%) → 4 = 35.01 AB	Mean 9= 59.92 A
Mean (Potassium nitrate (KNO_3) 10%) →5 = 38.86 AB	Mean 8= 51.14 A
Mean (Potassium nitrate (KNO_3) 15%) → 6 = 38.86 AB	Mean 7= 51.14 A
Mean (Propolis (2.5%) + KNO_3 (2.5%) →7 = 51.14 A	Mean 5= 38.86 AB
Mean (Propolis (5%) + KNO_3 (5%) →8 = 51.14 A	Mean 6= 38.86 AB
Mean (Propolis (7.5%) + KNO_3 (7.5%) →9 = 59.92 A	Mean 4= 35.01 AB
Mean (Control (Un treated)) →10 = 8.857 B	Mean 10= 8.857 B

Appendix 2.

Number of Leaves / 10 days

Treatment	**R1**	**R2**	**R3**
Propolis 5%	14	15.3	14
Propolis 10%	24	14	10
Propolis 15%	18	16	16
Potassium nitrate (KNO_3) 5%	6	10	16
Potassium nitrate (KNO_3) 10%	16	10	10
Potassium nitrate (KNO_3) 15%	22	6	10
Propolis (2.5%) + KNO_3 (2.5%)	14	18	6
Propolis (5%) + KNO_3 (5%)	16	10	16
Propolis (7.5%) + KNO_3 (7.5%)	12	12	24
Control (Un treated)	4	4	8

Number of Leaves / 20 days

Treatment	**R1**	**R2**	**R3**
Propolis 5%	252	161	152
Propolis 10%	248	120	240
Propolis 15%	196	264	230
Potassium nitrate (KNO_3) 5%	128	136	132
Potassium nitrate (KNO_3) 10%	144	184	104
Potassium nitrate (KNO_3) 15%	263	228	60
Propolis (2.5%) + KNO_3 (2.5%)	146	176.7	198.7
Propolis (5%) + KNO_3 (5%)	298	96	160
Propolis (7.5%) + KNO_3 (7.5%)	204	148	180
Control (Un treated)	84	72	96

Number of Leaves / 30 days

Treatment	**R1**	**R2**	**R3**
Propolis 5%	496	204	164
Propolis 10%	310.5	348	273
Propolis 15%	388	200	392
Potassium nitrate (KNO_3) 5%	188	184	64
Potassium nitrate (KNO_3) 10%	292	188	204
Potassium nitrate (KNO_3) 15%	204	256	230
Propolis (2.5%) + KNO_3 (2.5%)	280	332	188
Propolis (5%) + KNO_3 (5%)	186	304.3	276
Propolis (7.5%) + KNO_3 (7.5%)	385	380	80
Control (Un treated)	104	140	122

Data file:
PROPLS2
Title: number of leaves
Function: ANOVA-1
Data case no. 1 to 30
One way ANOVA grouped over variable 2 (TRT)
with values from 1 to 10.
Variable 3 (No. of leaves after 10 days)

A N A L Y S I S O F V A R I A N C E T A B L E

	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Prob.
Treatment	9	0.924	0.103	1.539	0.2014
Within	20	1.334	0.067		
Total	29	2.258			

Coefficient of Variation = 16.03%

Var. V A R I A B L E No. 3

2	Number	Sum	Average	SD	SE
1	3.00	5.030	1.677	0.18	0.15
2	3.00	5.280	1.760	0.31	0.15
3	3.00	4.770	1.590	0.33	0.15
4	3.00	5.270	1.757	0.33	0.15
5	3.00	3.510	1.170	0.16	0.15
6	3.00	5.430	1.810	0.05	0.15
7	3.00	4.730	1.577	0.42	0.15
8	3.00	4.720	1.573	0.18	0.15
9	3.00	4.470	1.490	0.28	0.15
10	3.00	5.110	1.703	0.04	0.15
Total	30.00	48.320	1.611	0.28	0.05
Within			0.26		

Bartlett's test

Chi-square = 11.595
Number of Degrees of Freedom = 9
Approximate significance = 0.237

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Variable 4 (No. of leaves after 20 days)

A N A L Y S I S O F V A R I A N C E T A B L E

	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Prob.
Treatment	9	10.328	1.148	1.287	0.3029
Within	20	17.828	0.891		
Total	29	28.156			

Coefficient of Variation = 17.83%

Var. V A R I A B L E No. 4

2	Number	Sum	Average	SD	SE
1	3.00	17.360	5.787	1.09	0.55
2	3.00	18.660	6.220	0.46	0.55
3	3.00	16.100	5.367	1.86	0.55
4	3.00	14.750	4.917	0.68	0.55
5	3.00	11.950	3.983	0.55	0.55
6	3.00	16.410	5.470	0.43	0.55
7	3.00	16.350	5.450	1.52	0.55
8	3.00	16.830	5.610	0.79	0.55
9	3.00	14.220	4.740	0.07	0.55
10	3.00	16.250	5.417	0.41	0.55
Total	30.00	158.880	5.296	0.99	0.18
Within			0.94		

Bartlett's test

Chi-square = 15.875

Number of Degrees of Freedom = 9

Approximate significance = 0.070

==========

Variable 5 (No. of leaves after 30 days)

A N A L Y S I S O F V A R I A N C E T A B L E

	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Prob.
Treatment	9	22.207	2.467	1.393	0.2555
Within	20	35.417	1.771		
Total	29	57.624			

Coefficient of Variation = 21.27%

Var. V A R I A B L E No. 5

2	Number	Sum	Average	SD	SE
1	3.00	22.000	7.333	1.31	0.77
2	3.00	21.660	7.220	0.44	0.77
3	3.00	19.750	6.583	2.48	0.77
4	3.00	18.670	6.223	0.35	0.77
5	3.00	14.560	4.853	1.31	0.77
6	3.00	18.520	6.173	0.73	0.77
7	3.00	20.270	6.757	2.07	0.77
8	3.00	18.980	6.327	1.49	0.77
9	3.00	13.660	4.553	0.33	0.77
10	3.00	19.590	6.530	0.81	0.77
Total	30.00	187.660	6.255	1.41	0.26
Within			1.33		

Bartlett's test

Chi-square = 12.800

Number of Degrees of Freedom = 9

Approximate significance = 0.172

Data File: PROPLS2

Title: number of leaves after 10 days

Case Range: 31 - 40

Variable 3 : No. of leaves 10

Function :

RANGE

Error Mean Square = 0.06700

Error Degrees of Freedom = 20

No. of observations to calculate a mean = 3

Duncan's Multiple Range Test

LSD value = 0.4409

s_ = 0.1494 at alpha = 0.050

x

Original Order	Ranked Order
Mean (Propolis 5%) → 1 =1.703 A	Mean 3 =1.810 A
Mean (Propolis 10%) → 2 = 1.757 A	Mean 9= 1.760 A
Mean (Propolis 15%) → 3 = 1.810 A	Mean 2= 1.757 A
Mean (Potassium nitrate (KNO_3) 5%) → 4 = 1.490 AB	Mean 1= 1.703 A
Mean (Potassium nitrate (KNO_3) 10%) →5 = 1.573 AB	Mean 8= 1.677 A
Mean (Potassium nitrate (KNO_3) 15%) → 6 = 1.577 AB	Mean 7= 1.590 AB
Mean (Propolis (2.5%) + KNO_3 (2.5%) →7 = 1.590 AB	Mean 6= 1.577 AB
Mean (Propolis (5%) + KNO_3 (5%) →8 = 1.677 A	Mean 5= 1.573 AB
Mean (Propolis (7.5%) + KNO_3 (7.5%) →9 = 1.760 A	Mean 4= 1.490 AB
Mean (Control (Un treated)) →10 = 1.170 B	Mean 10= 1.170 B

Data File : PROPLS2

Title: number of leaves after 20 days

Case Range: 31 - 40

Variable 4: No. of leaves 20

Function :

RANGE

Error Mean Square = 0.8910

Error Degrees of Freedom = 20

No. of observations to calculate a mean = 3

Duncan's Multiple Range Test

LSD value = 1.608

s_ = 0.5450 at alpha = 0.050

x

Original Order	Ranked Order
Mean (Propolis 5%) → 1 = 5.610 AB	Mean 3 = 6.220 A
Mean (Propolis 10%) → 2 = 5.787 AB	Mean 2= 5.787 AB
Mean (Propolis 15%) → 3 =6.220 A	Mean1= 5.610 AB
Mean (Potassium nitrate (KNO_3) 5%) → 4 =4.740 AB	Mean 9= 5.470 AB
Mean (Potassium nitrate (KNO_3) 10%) →5 =4.917 AB	Mean 8= 5.450 AB
Mean (Potassium nitrate (KNO_3) 15%) → 6 = 5.367 AB	Mean 7=5.417 AB
Mean (Propolis (2.5%) + KNO_3 (2.5%) →7 = 5.417 AB	Mean 6= 5.367 AB
Mean (Propolis (5%) + KNO_3 (5%) →8 =5.450 AB	Mean5= 4.917 AB
Mean (Propolis (7.5%) + KNO_3 (7.5%) →9 =5.470 AB	Mean 4= 4.740 AB
Mean (Control (Un treated)) →10 =3.983 B	Mean 10= 3.983 B

Data File: PROPLS2

Title: number of leaves after 30 days

Case Range: 31 - 40

Variable 5 : No. of leaves 30

Function :

RANGE

Error Mean Square = 1.771

Error Degrees of Freedom = 20

No. of observations to calculate a mean = 3

Duncan's Multiple Range Test

LSD value = 2.267

s_ = 0.7683 at alpha = 0.050

x

Original Order	Ranked Order
Mean (Propolis 5%) → 1 =6.757 AB	Mean 3 =7.333 A
Mean (Propolis 10%) → 2 =7.220 A	Mean 2 =7.220 A
Mean (Propolis 15%) → 3 =7.333 A	Mean 1= 6.757 AB
Mean (Potassium nitrate (KNO_3) 5%) → 4 =4.853 AB	Mean 9= 6.583 AB
Mean (Potassium nitrate (KNO_3) 10%) →5 = 6.173 AB	Mean 8= 6.530 AB
Mean (Potassium nitrate (KNO_3) 15%) → 6 =6.223 AB	Mean 7= 6.327 AB
Mean (Propolis (2.5%) + KNO_3 (2.5%) →7 =6.327 AB	Mean 6= 6.223 AB
Mean (Propolis (5%) + KNO_3 (5%) →8 =6.530 AB	Mean 5= 6.173 AB
Mean (Propolis (7.5%) + KNO_3 (7.5%) →9 = 6.583 AB	Mean 4= 4.853 AB
Mean (Control (Un treated)) →10 = 4.553 B	Mean10= 4.553 B

Appendix 3.

Plant hight / 10 days

Treatment	R1	R2	R3	Mean
Propolis 5%	8	7	7	7.33
Propolis 10%	7.5	7	8	7.50
Propolis 15%	11	5	9	8.33
Potassium nitrate (KNO_3) 5%	5	7	3	5.00
Potassium nitrate (KNO_3) 10%	9.6	3	4.5	5.70
Potassium nitrate (KNO_3) 15%	4	8	6	6.00
Propolis (2.5%) + KNO_3 (2.5%)	10	5	5	6.67
Propolis (5%) + KNO_3 (5%)	7	8	6	7.00
Propolis (7.5%) + KNO_3 (7.5%)	7.2	7.7	9.7	8.20
Control (Un treated)	3.5	2	5	3.50

Plant hight / 20 days

Treatment	R1	R2	R3	Mean
Propolis 5%	12.15	14.5	9.8	12.15
Propolis 10%	15.3	14.5	10	13.27
Propolis 15%	16.8	14	12	14.27
Potassium nitrate (KNO_3) 5%	13.2	5.7	10.5	9.80
Potassium nitrate (KNO_3) 10%	17.5	6	9.5	11.00
Potassium nitrate (KNO_3) 15%	14.5	9.5	12	12.00
Propolis (2.5%) + KNO_3 (2.5%)	12	9.8	9.9	10.57
Propolis (5%) + KNO_3 (5%)	5.2	17.9	11.5	11.53
Propolis (7.5%) + KNO_3 (7.5%)	14	10.5	14.7	13.07
Control (Un treated)	5	5	11.1	7.03

Plant hight / 30 days

Treatment	R1	R2	R3	Mean
Propolis 5%	76	43.5	34.5	51.33
Propolis 10%	68	35	64.5	55.83
Propolis 15%	63.25	88.5	38	56.22
Potassium nitrate (KNO_3) 5%	20.5	40.5	30.5	30.50
Potassium nitrate (KNO_3) 10%	58	25	40	41.00
Potassium nitrate (KNO_3) 15%	33	48	40.5	40.50
Propolis (2.5%) + KNO_3 (2.5%)	74	52	16	47.33
Propolis (5%) + KNO_3 (5%)	40.3	57	44.5	47.27
Propolis (7.5%) + KNO_3 (7.5%)	29.5	74	45.5	49.67
Control (Un treated)	34	31	21	28.67

Data file: PROPLIS
Title: plant hight
Function: ANOVA-1
Data case no. 1 to 30
One way ANOVA grouped over variable 2 (TRT)
with values from 1 to 10.
Variable 3 (PH(cm)10)

A N A L Y S I S O F V A R I A N C E T A B L E

	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Prob.
Treatment	9	2.530	0.281	1.751	0.1423
Within	20	3.212	0.161		
Total	29	5.743			

Coefficient of Variation = 15.33%

Var. V A R I A B L E No. 3

2	Number	Sum	Average	SD	SE
1	3.00	8.820	2.940	0.53	0.23
2	3.00	8.400	2.800	0.10	0.23
3	3.00	6.960	2.320	0.44	0.23
4	3.00	8.210	2.737	0.19	0.23
5	3.00	5.930	1.977	0.39	0.23
6	3.00	8.490	2.830	0.09	0.23
7	3.00	7.290	2.430	0.68	0.23
8	3.00	7.940	2.647	0.51	0.23
9	3.00	7.590	2.530	0.40	0.23
10	3.00	8.820	2.940	0.22	0.23
Total	30.00	78.450	2.615	0.44	0.08
Within			0.40		

Bartlett's test

Chi-square = 10.511
Number of Degrees of Freedom = 9
Approximate significance = 0.311

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Variable 4: plant hight (cm)(after 20 days)

A N A L Y S I S O F V A R I A N C E T A B L E

	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Prob.
Treatment	9	2.614	0.290	0.823	
Within	20	7.057	0.353		
Total	29	9.671			

Coefficient of Variation = 17.73%

Var. V A R I A B L E No. 4

2	Number	Sum	Average	SD	SE
1	3.00	9.510	3.170	0.62	0.34
2	3.00	9.580	3.193	0.66	0.34
3	3.00	11.080	3.693	0.40	0.34
4	3.00	10.640	3.547	0.33	0.34
5	3.00	8.110	2.703	0.61	0.34
6	3.00	10.030	3.343	0.55	0.34
7	3.00	9.950	3.317	0.86	0.34
8	3.00	11.510	3.837	0.31	0.34
9	3.00	10.140	3.380	0.95	0.34
10	3.00	9.970	3.323	0.19	0.34
Total	30.00	100.520	3.351	0.58	0.11
Within			0.59		

Bartlett's test

Chi-square = 6.301

Number of Degrees of Freedom = 9

Approximate significance = 0.709

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Variable 5 : plant hight (cm)(after 30 days)

A N A L Y S I S O F V A R I A N C E T A B L E

	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Prob.
Treatment	9	16.606	1.845	1.020	0.4574
Within	20	36.175	1.809		
Total	29	52.781			

Coefficient of Variation = 20.21%

Var. V A R I A B L E No. 5

2	Number	Sum	Average	SD	SE
1	3.00	22.300	7.433	1.28	0.78
2	3.00	23.610	7.870	1.62	0.78
3	3.00	19.940	6.647	2.34	0.78
4	3.00	19.150	6.383	0.59	0.78
5	3.00	16.120	5.373	0.65	0.78
6	3.00	19.060	6.353	1.30	0.78
7	3.00	21.300	7.100	1.47	0.78
8	3.00	20.890	6.963	1.58	0.78
9	3.00	16.550	5.517	0.91	0.78
10	3.00	20.680	6.893	0.62	0.78
Total	30.00	199.600	6.653	1.35	0.25
Within			1.34		

Bartlett's test

Chi-square = 6.157

Number of Degrees of Freedom = 9

Approximate significance = 0.724

Data File : PROPLIS

Title : plant hight

Case Range : 41 - 50

Variable 3 : PH(cm)10

Function : RANGE

Error Mean Square = 0.1610

Error Degrees of Freedom = 20

No. of observations to calculate a mean = 3

Duncan's Multiple Range Test

LSD value = 0.6834

s_ = 0.2317 at alpha = 0.050

x

Original Order	Ranked Order
Mean (Propolis 5%) → 1 = 2.800 A	Mean3 = 2.940 A
Mean (Propolis 10%) → 2 = 2.830 A	Mean 9 =2.940 A
Mean (Propolis 15%) → 3 =2.940 A	Mean 2 = 2.830 A
Mean (Potassium nitrate (KNO_3) 5%) → 4 =2.320 AB	Mean 1= 2.800 A
Mean (Potassium nitrate (KNO_3) 10%) →5 = 2.430 AB	Mean 8 = 2.737 AB
Mean (Potassium nitrate (KNO_3) 15%) → 6 = 2.530 AB	Mean 7= 2.647 AB
Mean (Propolis (2.5%) + KNO_3 (2.5%) →7 =2.647 AB	Mean 6 = 2.530 AB
Mean (Propolis (5%) + KNO_3 (5%) →8 =2.737 AB	Mean 5 = 2.430 AB
Mean (Propolis (7.5%) + KNO_3 (7.5%) →9 = Mean 9 = 2.940 A	Mean 4 = 2.320 AB
Mean (Control (Un treated)) →10 =1.977 B	Mean 10= 1.977 B

Data File : PROPLIS

Title : plant hight

Case Range : 41 - 50

Variable 4 : PH(cm)20

Function : RANGE

Error Mean Square = 0.3530

Error Degrees of Freedom = 20

No. of observations to calculate a mean = 3

Duncan's Multiple Range Test

LSD value = 1.012

s_ = 0.3430 at alpha = 0.050

x

Original Order	Ranked Order
Mean (Propolis 5%) → 1 = 3.547 A	Mean 3 = 3.837 A
Mean (Propolis 10%) → 2 = 3.693 A	Mean 2= 3.693 A
Mean (Propolis 15%) → 3 = 3.837 A	Mean 1 = 3.547 A
Mean (Potassium nitrate (KNO_3) 5%) → 4 = 3.170 A	Mean 9 = 3.380 A
Mean (Potassium nitrate (KNO_3) 10%) →5 = 3.193 A	Mean 8= 3.343 A
Mean (Potassium nitrate (KNO_3) 15%) → 6 =3.317 A	Mean 7 = 3.323 A
Mean (Propolis (2.5%) + KNO_3 (2.5%) →7 = 3.323 A	Mean 6 = 3.317 A
Mean (Propolis (5%) + KNO_3 (5%) →8 = 3.343 A	Mean 5 = 3.193 A
Mean (Propolis (7.5%) + KNO_3 (7.5%) →9 = 3.380 A	Mean 4 = 3.170 A
Mean (Control (Un treated)) →10 = 2.703 A	Mean 10 = 2.703 A

Data File : PROPLIS

Title : plant hight

Case Range : 41 - 50

Variable 5 : PH(cm)30

Function : RANGE

Error Mean Square = 1.809

Error Degrees of Freedom = 20

No. of observations to calculate a mean = 3

Duncan's Multiple Range Test

LSD value = 2.291

s_ = 0.7765 at alpha = 0.050

x

Original Order	Ranked Order
Mean (Propolis 5%) → 1 = 7.100 A	Mean 3= 7.870 A
Mean (Propolis 10%) → 2 = 7.433 A	Mean 2 = 7.433 A
Mean (Propolis 15%) → 3 = 7.870 A	Mean 1 = 7.100 A
Mean (Potassium nitrate (KNO_3) 5%) → 4 =5.517 A	Mean 9= 6.963 A
Mean (Potassium nitrate (KNO_3) 10%) →5 = 6.353 A	Mean 8 = 6.893 A
Mean (Potassium nitrate (KNO_3) 15%) → 6 = 6.383 A	Mean 7 = 6.647 A
Mean (Propolis (2.5%) + KNO_3 (2.5%) →7 = 6.647 A	Mean 6= 6.383 A
Mean (Propolis (5%) + KNO_3 (5%) →8 = 6.893 A	Mean 5 = 6.353 A
Mean (Propolis (7.5%) + KNO_3 (7.5%) →9 = 6.963 A	Mean 4= 5.517 A
Mean (Control (Un treated)) →10 = 5.373 A	Mean 10 = 5.373 A

Appendix 4.

Fresh weight of Pods

Treatment	R1	R2	R3	Total	Mean
Propolis 5%	118.2	116.9	115	350.1	116.7
Propolis 10%	130	134	129	393	131
Propolis 15%	215.1	219.8	216.1	651	217
Potassium nitrate (KNO_3) 5%	88.3	86.9	87.6	262.8	87.6
Potassium nitrate (KNO_3) 10%	92.9	86.6	89.9	269.4	89.8
Potassium nitrate (KNO_3) 15%	94.2	95.1	91.8	281.1	93.7
Propolis (2.5%) + KNO_3 (2.5%)	90.9	98	100	288.9	96.3
Propolis (5%) + KNO_3 (5%)	104.9	102	107.5	314.4	104.8
Propolis (7.5%) + KNO_3 (7.5%)	109	106.4	105.6	321	107
Control (Un treated)	82.3	83.2	79.3	244.8	81.6

Dry weight of Pods

TRT	R1	R2	R3	Total	Mean
Propolis 5%	40.9	41.5	44.2	126.6	42.2
Propolis 10%	59.8	54.7	55	169.5	56.5
Propolis 15%	145	139.6	142.9	427.5	142.5
Potassium nitrate (KNO_3) 5%	13.3	14.2	11.8	39.3	13.1
Potassium nitrate (KNO_3) 10%	16.6	13.4	15.9	45.9	15.3
Potassium nitrate (KNO_3) 15%	18.6	21.8	17.2	57.6	19.2
Propolis (2.5%) + KNO_3 (2.5%)	22.8	23.6	19	65.4	21.8
Propolis (5%) + KNO_3 (5%)	28.9	32.3	29.7	90.9	30.3
Propolis (7.5%) + KNO_3 (7.5%)	32.4	33.7	31.4	97.5	32.5
Control (Un treated)	7.7	8.1	5.5	21.3	7.1

Fresh weight of Shoots

TRT	R1	R2	R3	Total	Mean
Propolis 5%	229.2	227.1	235.2	691.5	230.5
Propolis 10%	257.4	260	254.8	772.2	257.4
Propolis 15%	450	455.1	451	1354.2	451.4
Potassium nitrate (KNO_3) 5%	186.4	188.8	193.6	568.8	189.6
Potassium nitrate (KNO_3) 10%	145	134	141	420	140
Potassium nitrate (KNO_3) 15%	188.2	193	187.9	569.1	189.7
Propolis (2.5%) + KNO_3 (2.5%)	191.1	187.7	190.9	569.7	189.9
Propolis (5%) + KNO_3 (5%)	215	211	211.8	637.8	212.6
Propolis (7.5%) + KNO_3 (7.5%)	233.9	231.1	238.2	703.2	234.4
Control (Un treated)	100	98.7	95.9	294.6	98.2

Dry weight of Shoots

TRT	R1	R2	R3	Total	Mean
Propolis 5%	159.4	151.3	157.3	468	156
Propolis 10%	161.2	162.8	155.7	479.7	159.9
Propolis 15%	373.9	381.1	375.7	1130.7	376.9
Potassium nitrate (KNO_3) 5%	63.8	61.5	71.2	196.5	65.5
Potassium nitrate (KNO_3) 10%	113.7	111.8	120.1	345.6	115.2
Potassium nitrate (KNO_3) 15%	119	112.4	113.9	345.3	115.1
Propolis (2.5%) + KNO_3 (2.5%)	110.5	121	114.7	346.2	115.4
Propolis (5%) + KNO_3 (5%)	136	141.1	137.2	414.3	138.1
Propolis (7.5%) + KNO_3 (7.5%)	187.5	178.4	182.8	548.7	182.9
Control (Un treated)	25.7	23.3	22.1	71.1	23.7

Data File : LAB2

Title : fresh and dry weight

Case Range : 31 - 40

Variable 4 : FD

Function : RANGE

Error Mean Square = 0.06200

Error Degrees of Freedom = 20

No. of observations to calculate a mean = 3

Duncan's Multiple Range Test

LSD value = 0.4241

s_ = 0.1438 at alpha = 0.050

x

Original Order	Ranked Order
Mean (Propolis 5%) → 1 = 4.720 F	Mean10 = 11.96 A
Mean (Propolis 10%) → 2 = 3.973 G	Mean 8 = 7.550 B
Mean (Propolis 15%) → 3 = 3.683 G	Mean 4 = 6.533 C
Mean (Potassium nitrate (KNO_3) 5%) → 4 = 6.533 C	Mean 6 = 6.080 D
Mean (Potassium nitrate (KNO_3) 10%) →5 = 5.550E	Mean 5 =5.550 E
Mean (Potassium nitrate (KNO_3) 15%) → 6 = 6.080 D	Mean 1 = 4.720 F
Mean (Propolis (2.5%) + KNO_3 (2.5%) →7 = 4.433 F	Mean 7 = 4.433 F
Mean (Propolis (5%) + KNO_3 (5%) →8 =7.550 B	Mean 2 = 3.973G
Mean (Propolis (7.5%) + KNO_3 (7.5%) →9 = 2.747 H	Mean 3 = 3.683 G
Mean (Control (Un treated)) →10 =11.96 A	Mean 9 = 2.747 H

Data File: LAB2

Title: fresh and dry weight

Case Range: 31 - 40

Variable 3 : FF

Function: RANGE

Error Mean Square = 0.1120

Error Degrees of Freedom = 20

No. of observations to calculate a mean = 3

Duncan's Multiple Range Test

LSD value = 0.5700

s_ = 0.1932 at alpha = 0.050

x

Original Order	Ranked Order
Mean (Propolis 5%) → 1 = 9.990 DE	Mean10 = 14.91 A
Mean (Propolis 10%) → 2 = 9.660 EF	Mean8 = 11.63 B
Mean (Propolis 15%) → 3 = 9.547 EF	Mean4 = 10.99 C
Mean (Potassium nitrate (KNO_3) 5%) → 4 =10.99C	Mean 6 = 10.53 CD
Mean (Potassium nitrate (KNO_3) 10%) →5 = 10.42 CD	Mean 5 = 10.42 CD
Mean (Potassium nitrate (KNO_3) 15%) → 6 =10.53 CD	Mean 1 = 9.990 DE
Mean (Propolis (2.5%) + KNO_3 (2.5%) →7 =9.717 EF	Mean 7 = 9.717 EF
Mean (Propolis (5%) + KNO_3 (5%) →8 =11.63 B	Mean 2 = 9.660 EF
Mean (Propolis (7.5%) + KNO_3 (7.5%) →9 =9.217 F	Mean 3 = 9.547 EF
Mean (Control (Un treated)) →10 =14.91 A	Mean 9 = 9.217 F

Data File :LAB2

Title : fresh and dry weight

Case Range : 31 - 40

Variable 6 : SHD

Function : RANGE

Error Mean Square = 0.06300

Error Degrees of Freedom = 20

No. of observations to calculate a mean = 3

Duncan's Multiple Range Test

LSD value = 0.4275

s_ = 0.1449 at alpha = 0.050

x

Original Order	Ranked Order
Mean (Propolis 5%) → 1 = 12.67 C	Mean 10 = 19.43 A
Mean (Propolis 10%) → 2 = 10.76 E	Mean 8 = 13.54 B
Mean (Propolis 15%) → 3 = 10.76 E	Mean 1 = 12.67 C
Mean (Potassium nitrate (KNO_3) 5%) → 4 = 10.75 E	Mean 6 = 12.51 C
Mean (Potassium nitrate (KNO_3) 10%) →5 = 11.77 D	Mean 5 = 11.77 D
Mean (Potassium nitrate (KNO_3) 15%) → 6 = 12.51 C	Mean 3 = 10.76 E
Mean (Propolis (2.5%) + KNO_3 (2.5%) →7 = 8.120 F	Mean 2 = 10.76 E
Mean (Propolis (5%) + KNO_3 (5%) →8 = 13.54 B	Mean 4 = 10.75 E
Mean (Propolis (7.5%) + KNO_3 (7.5%) →9 = 4.917 G	Mean 7 = 8.120 F
Mean (Control (Un treated)) →10 = 19.43 A	Mean 9 = 4.917 G

Data File :LAB2

Title : fresh and dry weight

Case Range : 31 - 40

Variable 5 : SHF

Function : RANGE

Error Mean Square = 0.01400

Error Degrees of Freedom = 20

No. of observations to calculate a mean = 3

Duncan's Multiple Range Test

LSD value = 0.2015

s_ = 0.06831 at alpha = 0.050

x

Original Order	Ranked Order
Mean (Propolis 5%) → 1 = 15.33C	Mean 10 = 21.27 A
Mean (Propolis 10%) → 2 = 13.79 E	Mean 8 = 16.06 B
Mean (Propolis 15%) → 3 = 13.80E	Mean 1 = 15.33 C
Mean (Potassium nitrate (KNO_3) 5%) → 4 = 13.79E	Mean 6 = 15.20 C
Mean (Potassium nitrate (KNO_3) 10%) →5 = 14.60 D	Mean 5 = 14.60 D
Mean (Potassium nitrate (KNO_3) 15%) → 6 = 15.20 C	Mean 3 = 13.80 E
Mean (Propolis (2.5%) + KNO_3 (2.5%) →7 = 11.85F	Mean 2 = 13.79 E
Mean (Propolis (5%) + KNO_3 (5%) →8 = 16.06B	Mean 4 = 13.79 E
Mean (Propolis (7.5%) + KNO_3 (7.5%) →9 = 9.933 G	Mean 7 = 11.85 F
Mean (Control (Un treated)) →10 = 21.27 A	Mean 9 = 9.933 G

Data file: LAB2
Title: fresh and dry weight
Function: ANOVA-1
Data case no. 1 to 30
One way ANOVA grouped over variable 2 (TRT)
with values from 1 to 10.
Variable 3 (FF)

A N A L Y S I S O F V A R I A N C E T A B L E

	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Prob.
Treatment	9	74.526	8.281	73.748	0.0000
Within	20	2.246	0.112		
Total	29	76.772			

Coefficient of Variation = 3.14%

Var. V A R I A B L E No. 3

2	Number	Sum	Average	SD	SE
1	3.00	29.970	9.990	0.06	0.19
2	3.00	28.980	9.660	0.43	0.19
3	3.00	28.640	9.547	0.31	0.19
4	3.00	32.960	10.987	0.34	0.19
5	3.00	31.250	10.417	0.31	0.19
6	3.00	31.580	10.527	0.36	0.19
7	3.00	29.150	9.717	0.53	0.19
8	3.00	34.880	11.627	0.26	0.19
9	3.00	27.650	9.217	0.33	0.19
10	3.00	44.730	14.910	0.23	0.19
Total	30.00	319.790	10.660	1.63	0.30
Within			0.34		

Bartlett's test

Chi-square = 5.925
Number of Degrees of Freedom = 9
Approximate significance = 0.747

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Variable 4: (fresh and dry weight)

A N A L Y S I S O F V A R I A N C E T A B L E

	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Prob.
Treatment	9	185.280	20.587	333.549	0.0000
Within	20	1.234	0.062		
Total	29	186.514			

Coefficient of Variation = 4.34%

Var. V A R I A B L E No. 4

2	Number	Sum	Average	SD	SE
1	3.00	14.160	4.720	0.26	0.14
2	3.00	11.920	3.973	0.22	0.14
3	3.00	11.050	3.683	0.16	0.14
4	3.00	19.600	6.533	0.14	0.14
5	3.00	16.650	5.550	0.16	0.14
6	3.00	18.240	6.080	0.50	0.14
7	3.00	13.300	4.433	0.26	0.14
8	3.00	22.650	7.550	0.19	0.14
9	3.00	8.240	2.747	0.26	0.14
10	3.00	35.870	11.957	0.11	0.14
Total	30.00	171.680	5.723	2.54	0.46
Within			0.25		

Bartlett's test

Chi-square = 6.175

Number of Degrees of Freedom = 9

Approximate significance = 0.722

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Variable 5: Weights of fresh shoots

A N A L Y S I S O F V A R I A N C E T A B L E

	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Prob.
Treatment	9	236.320	26.258	1817.985	0.0000
Within	20	0.289	0.014		
Total	29	236.609			

Coefficient of Variation = 0.83%

Var. V A R I A B L E No. 5

2	Number	Sum	Average	SD	SE
1	3.00	45.980	15.327	0.12	0.07
2	3.00	41.380	13.793	0.10	0.07
3	3.00	41.390	13.797	0.07	0.07
4	3.00	41.360	13.787	0.13	0.07
5	3.00	43.790	14.597	0.07	0.07
6	3.00	45.600	15.200	0.13	0.07
7	3.00	35.560	11.853	0.23	0.07
8	3.00	48.180	16.060	0.08	0.07
9	3.00	29.800	9.933	0.10	0.07
10	3.00	63.810	21.270	0.06	0.07
Total	30.00	436.850	14.562	2.86	0.52
Within			0.12		

Bartlett's test

Chi-square = 5.531

Number of Degrees of Freedom = 9

Approximate significance = 0.786

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Variable 6: Weights of dry shoots

A N A L Y S I S O F V A R I A N C E T A B L E

	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Prob.
Treatment	9	377.621	41.958	1181.135	0.0000
Within	20	0.710	0.036		
Total	29	378.331			

Coefficient of Variation = 1.64%

Var. V A R I A B L E No. 6

2	Number	Sum	Average	SD	SE
1	3.00	38.000	12.667	0.15	0.11
2	3.00	32.270	10.757	0.20	0.11
3	3.00	32.290	10.763	0.24	0.11
4	3.00	32.260	10.753	0.16	0.11
5	3.00	35.310	11.770	0.12	0.11
6	3.00	37.530	12.510	0.17	0.11
7	3.00	24.360	8.120	0.31	0.11
8	3.00	40.630	13.543	0.17	0.11
9	3.00	14.750	4.917	0.19	0.11
10	3.00	58.280	19.427	0.09	0.11
Total	30.00	345.680	11.523	3.61	0.66
Within			0.19		

Bartlett's test

Chi-square = 3.576

Number of Degrees of Freedom = 9

Approximate significance = 0.937