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Effect of seed priming through gibberellic acid (GA_3) and imidacloprid on bismarckia palm seed

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Abstract

Bismarckia nobilis is an oldest solitary silver blue fan palm of tropics and subtropics areas all through the world. A slow growing elegant ornamental, has currently a strong world demand as an outdoor plant in landscape industry from past twenty years. It is ideal for both domestic and commercial gardens as single specimen are also attractive and well suited for most of the residential landscape but seed germination is quiet slow and unequal. Thus the aim of present study is to assess the effect of seed priming method using different concentration of gibberellic acid (750mg/L, 1000mg/L, 1250mg/L) and imidacloprid (4g/kg, 6g/kg and 8g/kg) on *bismarckia nobilis* seed by breaking dormancy to get early germination. The following growth attributes like germination rate, germination percentage, plant height, leaf area, number of leaves and chlorophyll contents were studied in this experiment. The results demonstrate that priming among all the treatments of imidacloprid @ 6g/kg showed marked influence on plant height, leaf area, germination rate whereas gibberellic acid @ 1000 kg/L revealed maximum germination percentage but no effect on chlorophyll content was studied through these chemicals. Based on the results, imidacloprid being a cost effective chemical could be used as pre-treatment for inducing early germination in *bismarckia nobilis* seed as compared to gibberellic acid.

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Introduction

Bismarckia nobilis profound occupancy, attractive appearance, intense look and striking sliver-blue color are delight for landscape amongst other palms. It belongs to family Arecaceae and native to the Madagascar. Surrounded by large class of palms it is perennial, slow growing, requires partial to full sun light, hot and humid areas, reaching up to height of 60-100 feet with open and round symmetry, leaves are gigantic dramatic with blue green to blue gray in color which is waxy in texture and grown in variety of soils from acid to basic. It is progressive against drought, salinity and pests. It is propagated by seed and tree typically grown from 1-2 feet per year. It can be positioned together in a commercial or large suburban setting contrast intensely with present vegetation providing ideal relief from the greens so common in landscape mostly. Single specimens are also more eye-catching and well suited for most residential sized landscape (Gilman.E.F, 1997; Gilman and Watson, 2011). As it germinates from seed which plays a vital role in agriculture since ancient times. It is the first component for plant development and effective production (McDonald, 2000). *Bismarckia nobilis* is highly profitable commercial commodity but it requires more time to germinate because of its long dormancy period. Due to its slow and uneven germination character there is a great deal of attention in pre-treatments to speed up the germination rate and make an even germination (Klinger and Rejmanek, 2010; Moussa *et al.,* 1998; Gomes *et al.*, 2006; Yang *et al.*, 2007; Pinheiro, 2001; Potvin *et al.*, 2003). Dormancy is the fundamental obstruction of the germination of viable seeds under circumstances in which non-dormant seeds germinate (Finchsavage and Leubner-Metzer, 2006; Linkies *et al.*, 2010). Late seed germination in palms has been related with morphological dormancy due to embryo immaturity as well as physiological dormancy (Baskin and Baskin, 1998; Orozco-Segovia *et al.*, 2003). Dormancy in palms seeds at maturity has been reported for many palm species (Jones, 1984; Wagner, 1982; Wan and Hor, 1983).

Seed priming is a controlled practice which involves hydration and breaking of dormancy in seeds. In this technique seeds are pre-soaked in water or chemicals to the point where seeds metabolic activities starts but radical emergency does not occur. It boosts seeds performance presenting rapid and harmonized germination. (McDonald. 2000; Farooq *et al.*, 2007; hussain *et al.*, 2014). Seed priming along with various plant growth regulators is helpful for good yield and early growth. It also averts plants from damaging effects of environmental stress. (Bahrani and Pourea, 2012). Gibberellic acid is a plant growth regulator encouraging plant growth and development. (Gupta and Chakrabarty , 2013). It increases leaf area, stem elongation, internode length, dry mass and break dormancy (Kerbauy, 2004). Numerous studies have demonstrated the efficiency of gibberellins in stimulating germination and overcoming physiological dormancy in palm seeds (Chin *et al.,* 1988; Dewir *et al.*, 2011; Herrera *et al.*, 1998; Nagao *et al.,* 1980; Pérez *et al.*, 2008; Roberto and Habermann, 2010; Yang *et al.,* 2007; Ribeiro *et al.,* 2011). The use of gebberellic acid to stimulate germination of seeds which are physiologically dormant is also well documented (Abu Dahoub *et al.*, 1975; Albert, 1970; Anon, '1976, Chandra and Chauhan, 1976; Hartman and Kester, 1975; Krishnamoorthy, 1973; Venator, 1972). The germination of seeds of palm has been described to take 3 to 6 years (Jones, 1984).

This prolonged germination period lead to the short supply of plant material. Research work has been studied by many scientists on different palm species by presoaking the seeds in gibberellic acid to find its effect on early seed germination (Wan and Hor, 1983).

Imidacloprid is the first commercially existing illustrative of a new chemical class, the neonicotinoid insecticides. It was manufactured in 1985 and the first registration was attained in France 1991 in sugar beet. It is a systemic broad-spectrum insecticide and acts as a contact and stomach poison against sucking and some biting insects such as rice hoppers, aphids, thrips, whitefly, termites (Bai *et al.*, 1991; Nauen *et* *al.*, 1998; Schmuck *et al.,* 2003; Laurent and Rathahao, 2003). Neonicotenoid insecticides have pronounced systematic action on filed crop through seed treatment (Moser and Obryckri, 2009). By application on seed surface, the active ingredient of neonicotenoid is trans-located throughout the plant and also evenly distributed to whole plant (Magalhaes *et al.,* 2009). Publish data on neonicotenoids effect on germination and growth is also available beside its insecticidal effect (Nault *et al.*, 2004; Ramesh and Ukey, 2006). It is also reported to exhibit an effect on seed germination and seedling vigor in some crop (Horri *et al.,* 2007; Stevens *et al.,* 2008).

The present study is design elaborate the effect of seed priming method through imidaclorpid and gibberellic acid on bismarckia palm seed. This plan leads to break the early dormancy and help in selection of cost effective chemical between imidaclorpid and gibberellic acid.

Materials and methods

Experimental site and planting material

The Present research was laid at research area of horticulture department, Pir Mehr Ali Shah Arid Agriculture University Rawalpindi 33.60000 N, 73.03330. The temperature and humidity was maintained at 25-30°C and 75-85% respectively. Seeds of Bismarckia Palm were collected from Patoki near Lahore. A mixture of sand and soil in the ratio of 1:2 was filled in 14 inch long plastic bags. An ample space for seed germination was provided as the plumule of this palm seed first go downward about 10 inch and then went upward.

Treatments and analytical parameters

Different treatments combinations were as follows: T_0: Control, T_1: Gibberellic Acid (750mg/L), T_2: Gibberellic Acid (1000mg/L), T_3: Gibberellic Acid (1250mg/L), T_4: Imidacloprid (4g/kg seeds), T_5: Imidacloprid (6g/kg seeds), T_6: Imidacloprid (8g/kg seeds). Seeds of Bismarckia palm were dipped into the solution and soaked for 48 hours at room temperature. Before treatment with two chemicals (gibberellic acid and Imidacloprid) seeds were dipped in tap water for 48 hours.

Data Collection

Data for parameters determined were; the germination rate provided a measure of the time course of seed germination (Dewir *et al.,* 2011). Germination percentage was calculated as it is an estimate of the viability of a population of seeds (Dewir *et al.,* 2011).

$$\text{Germination \%} = \frac{\text{No. of seeds germinated}}{\text{Total Seeds}} \times 100$$

Number of leaves was calculated manually by counting number of leaves per plant. Chlorophyll contents were measured with the help of spade meter. Leaf area was measured manually by taking length and width of flag leaf using meter rod. Following formula was used for the measurement of leaf area (Muller, 1991).

Leaf Area = Length x Width x 0.74

Statistical Analysis

Complete Randomized Design (CRD) was used for this study. Data about the parameters were subjected to ANOVA (Analysis of Variance).

Results

Germination rate

Germination rate is the number of days requires by seed to germinate after sowing. Statistically analyzed data showed that the minimum germination rate 30.667 days was recorded in seed treated with Imidacloprid @ 8g/kg as compared to control which gave maximum germination rate 45.55 days. Among gibberellic acid treatment, seed treated with gibberellic acid @ 1250 mg/L gave better germination rate 34.73 days. As shown in (Table 1 & Figure 1)

Germination Percentage

As we know that germination percentage is the calculation of viable seeds from total seeds sown. Among seeds treated with gibberellic acid, maximum germination percentage 82.773 % was recorded in gibberellic Acid @ 1000 mg/L and minimum germination percentage was found in gibberellic Acid @ 1250 mg/L as compared to control which germination of 67.41 %.

While seed priming with Imidacloprid, maximum germination percentage 75.56 % was occupied by Imidacloprid @ 6g/kg seed as shown in (Table 1 & Figure 1). Germination percentage increased by gibberellic acid effectively in several species and also breaks dormancy (Ballington, 1984).

Plant height

With priming method seeds treated with imidaclorpid @ 6g/kg attain maximum plant height 56.943cm as compared to control which gave minimum plant height which was 45.24cm. While in gibberellic acid seeds treated with gibberellic acid @1250 mg/L attain maximum plant height of 56.30cm as compared to gibberellic acid @750mg/L giving minimum plant height 44.220cm. (Table 1 & Figure 1)

Number of Leaves

The increase in number of leaves 4.830 was recorded in seed treatment with Imidacloprid @ 8g/kg seed and secondly 4.413 in Imidacloprid treated seed at the rate of 6g/kg seed as compared to control which gave minimum number of leaves i.e. 2.90. While gibberellic acid @ 750 mg/L gave number of leaves 3.12 (Table 1 & Figure 1).

Table 1. Effect of different concentration of gibberellic acid and Imidacloprid on vegetative characters of *Bismarckia nobilis*.

Treatments	Germination rate	Germination percentage	Plant height (cm)	No. of leaves	Leaf area content	Leaf chlorophyll content
Control	45.553 A	67.41 AB	45.240 C	2.903 C	61.543 CD	49.057 AB
$GA_3$750mg/L	39 A	67.04 AB	44.220 C	3.120 C	56.026 C	51.023 A
$GA_3$1000mg/L	38.487 B	82.773 A	47.660 BC	2.956 C	62.063 CD	49.313 AB
$GA_3$1250mg/L	34.73 C	48.483 C	56.303 A	2.930 C	68.230 CD	48.743 AB
Imida 4g/kg	40.34 B	66.67 AB	54.417 C	3.940 B	75.093 BC	49.570 AB
Imida 6g/kg	32.267 C	75.56 A	56.943 A	4.431 AB	92.537 A	47.970 AB
Imida 8g/kg	30.667 D	51.85 BC	50.360 B	4.830 A	85.247 AB	47.500 B

Means not sharing an alphabet are significantly different at $p<0.05$.

Leaf area

Results indicated that maximum leaf area of 92.537 cm² was obtained from the seed treatment with Imidacloprid @ 6g/kg seed, while 85.247 cm² was obtained when treated with Imidacloprid @ 8g/kg seed followed by Imidacloprid @ 4g/kg seed which attain leaf area 75.093 cm². Among Gibberellic Acid treatment, gibberellic acid @ 1250 mg/L attain leaf area 68.230 cm² while gibberellic acid @ 1000 mg/L attain 62.063 cm² leaf area and minimum leaf area 56.020 cm² was recorded in seed primed with gibberellic acid @ 750mg/L. (Table 1 & Figure 1).

Chlorophyll content

No vital difference was noticed in chlorophyll content with different concentration of giberellic gibberellic acid and imidiaclorpid. Among gibberellic acid concentrations 750mg/L showed chlorophyll content 51.023 and minimum contents were found on gibberellic acid @ 1250mg/L. among imidiaclorpid 4g/kg seed gave chlorophyll content 49.570. (Table 1 & Figure 1).

Discussion

Results indicated that higher concentration of imidacloprid presented better results in plant height, leaf area, germination rate as compared to control because it increase the uptake of water, nutrients, its translocation and increase the metabolic activates from xylem and phloem by quickly degrading the active substances also speeding up the process. Imidacloprid with different application demonstrated that there is a good acropetal translocation of the active substance to shoots and leaves (Sur and Stork, 2003). Neonicotenoids also stimulated the seed germination in soybean, corn and pea (Horii *et al.*, 2007; Cataneo *et al.,* 2010). (Buchholz and Nauen, 2002) reported that if neonicotenoids applied as seed treatment it can maximize the uptake of tissue into the plant. Nicotinic acetylcholine receptor (nAchR) was encouraged by neonicotenoids (Yamamoto *et al.,* 1995; Matsuda *et al.,* 2000) and its interaction with nAchRs increases when any chemical is reduced by phenolic antioxidants (electrophilic compounds) to form positive charged particles. Such positively charged molecules will affect the electron-transport chain in plant tissue that will surely improve seed vigor (Ayyappath *et al.,* 2000; Delgarde, 2002; Foster *et al.*, 2003). Many research showed that germination rate is directly related to intensity of dormancy (Jensen and Eriksen, 2001).

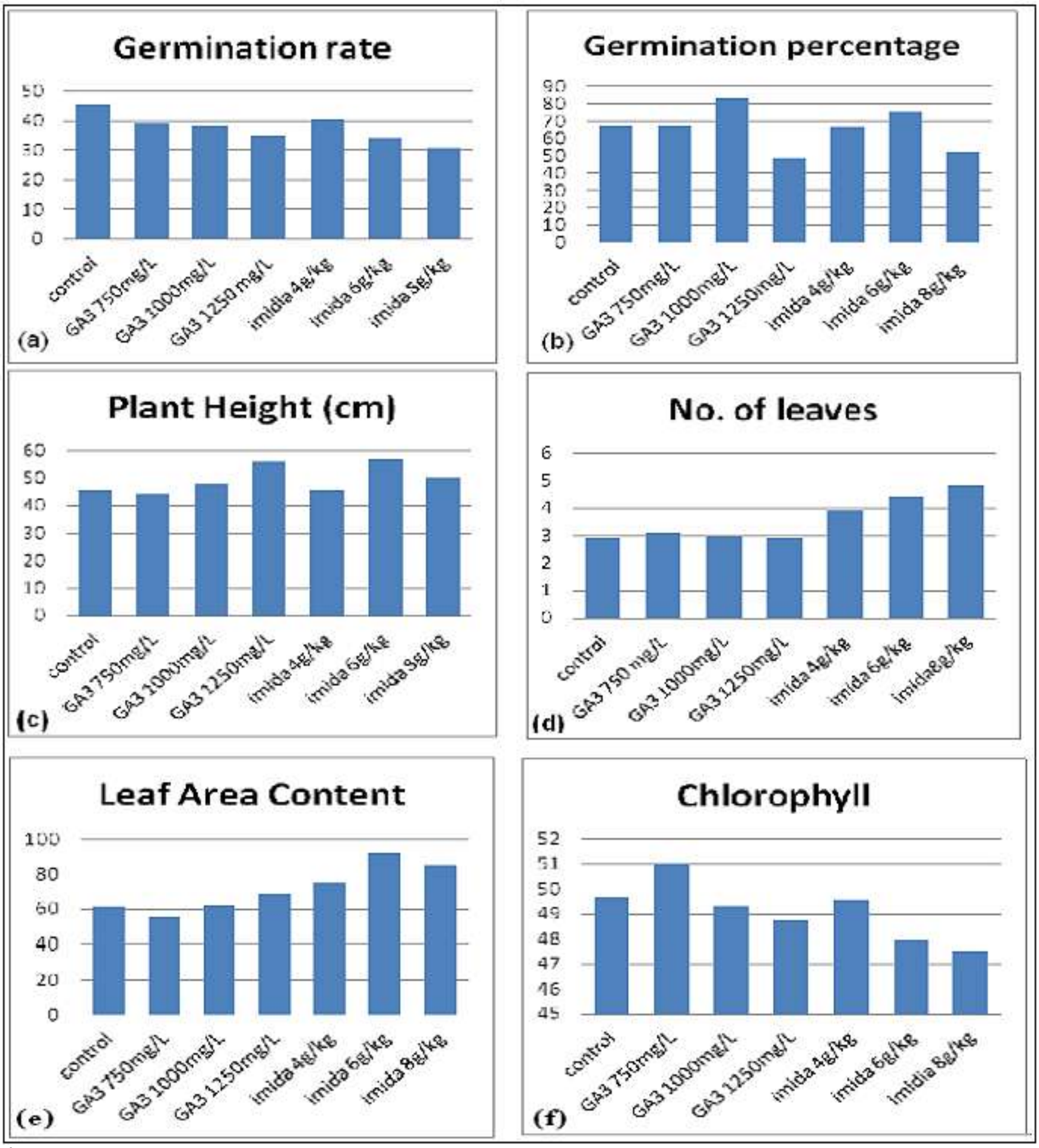

Fig. 1. Effect of different concentrations of gibberellic acid and imidacloprid on (a) Germination rate (b) germination (%) (c) Plant height (cm) (d) No. of leaves (e) leaf area content (f) chlorophyll of *Bismarckia nobilis.*

As we know that germination percentage is the calculation of viable seeds from total seeds sown. Data presented in Table 1 showed that the gibberellic acid @1000mg/L enhance germination percentage as compared to other (Figure 1) parameters during the course of investigation. Gibberellic acid breaks seed dormancy, promotes germination, intermodal length, hypocotyls growth and cell division in cambial zone and increases the size of leaves. It encourages hydrolytic enzymes that are desirable for the degradation of the cells adjoining the radicle and accordingly enhance germination by boosting seedling elongation growth of cereal seeds (Rood *et al.,* 1990). Blue berry seed's pretreatment with GA_{4+7} at 100-500 mg/L increased germination (Ballington, 1984). The progressive effects of immersion in gibberellic acid tended to increase with increasing numbers of applications in macaw palm for breaking its dormancy (Oliveira *et al.*, 2013) Eastern strawberry tree (Arbutus andrachna L.) seed's treatment with gibberellic acid at the rate of 250 mg/L had given 86% of germination (Karam and Al-Salem, 2001). It is also reported that gibberellic acid will increase germination in Vacciniummyrtillus L. seeds. Inhibitory effects in the seed will overcome through gibberellic acid (Giba *et al.*, 1993). Priming with low concentrations of gibberellic acid had no influence on germination rate and germination percent but it could increase shoot length, root length, dry weight, fresh weight and tissue water content but priming with higher concentrations of gibberellic acid had good effect on germination and growth of cereal (Naeem and Muhammad, 2006; Singh and Dara 1971). It was also reported that gibberellic acid also enhance the physiological activity of embryo (Farmer, 1997). So this was also a reason to increase the leaf area in *bismarckia nobilis* leaf. When seeds of Brassica rapa plant were dipped into gibberellic acid no significant difference seen in chlorophyll contents. Which is clearly supported our results. (Schulz *et al.*, 2007) reported in a fact sheet that when neonicotenoids were applied to soya beans seeds before sowing they have no major effect on the chlorophyll contents of leaves which also support our result on chlorophyll contents.

Conclusion

It was evident that when imidacloprid used for seed priming its reduction in germination rate was reduced from 2-3 months to 1 month. Germination percentage also increased up to 82% through imidacloprid as well as gibberellic acid. Considerable increased in plant height, leaf area and numbers of leaves were seen by using gibberellic acid and imidacloprid. No effect on chlorophyll content was observed through these chemical. From all the above discussion, one can recommend imidacloprid as seed priming agent to break dormancy of palm seed. It gives best results as compared to gibberellic acid and also it is an economical chemical. Keeping in view its economic viability, one can get profitable returns by using cost effective imidacloprid for inducing early germination in *Bismarckia nobilis.*

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