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INFLUENCE OF SEED TREATMENTS ON SEED QUALITY, SEED VIABILITY, AND SEEDLING VIGOR OF SOME PEANUT CULTIVARS UNDER SANDY SOIL CONDITIONS

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ABSTRACT: Seed treatment is a valuable approach for enhancing seed viability and seedling establishment of peanut. The present study aimed to assess the effect of different seed treatments on seed viability and seedling vigor of three peanut cultivars *q.e.* Giza-6, North Carolina, and Aramanch. The applied seed treatments were *Rhizobium* inoculation, gypsum, moringa leaf extract, Vitavax and Mixture. (Inoculation, Vitavax, Moringa) versus untreated control. The evaluated peanut cultivars substantially varied in their performance of quality traits, seed viability, and seedling vigor. The cultivars North Carolina and Giza-6 recorded the highest value for crude protein content, germination speed, germination energy, and percentage of good seedlings in both seasons and the combined analysis. Moreover, Aramanch and Giza-6 recorded the highest each of oil content, oil yield, germination percentage, germination index, seedling length, as well as seedling fresh and dry weights during both seasons and the combined analysis. The applied seed treatments substantially ameliorated peanut quality traits, seed viability, and seedling vigor. Gypsum, moringa extract, *Rhizobium* inoculation, and Vitavax displayed the highest crude protein content, oil content, germination percentage, germination index, germination speed, germination energy, percentage of good seedlings, seedling length, as well as seedling fresh and dry weights in both seasons and the combined analysis. Subsequently, the application of gypsum, moringa extract, *Rhizobium* inoculation, or Vitavax is an efficacious approach to reinforce seed quality, seed viability, and the seedling vigor of different peanut cultivars.

Key words: Oil content, crude protein, seed viability, seedling vigor.

INTRODUCTION

Peanut (*Arachis hypogea* L.) is major a legume crop grown principally for its edible seeds **(Li *et al.,* 2018).** It is widely cultivated due to its high oil content as an oil crop and is considered one of the cash crops (**Popoola *et al.,* 2022**). It is greatly nutritious due to containing 25% protein and 50% edible oil (**Javanmardi *et al.,* 2022**). It is utilized in the form of edible oil, shelled nuts, or distinct processing forms such as peanut butter, flour, sauce, or confectionery items (**Yin *et al.,* 2022**). Global annual production of shelled peanuts was 53.6 million ton produced from 31.5 million hectare in 2020 (**FAOSTAT, 2022**). Peanut is an annual summer crop in Egypt with acreage area about 64 thousand hectare in the 2020 with a total production of about 213.8 thousand ton with an average productivity of 3.34 ton/ha.

Seed viability and seedling vigor are crucial factors for the successful growth of peanut (**Prasad *et al.,* 2020**). Rapid germination, vigorous seedlings, uniform emergence, and strong early growth reflect a high potential for crop stand establishment and a successful cropping system (**Damalas *et al.,* 2019**). Improving stand establishment is a vital prerequisite for high growth and productivity (**Sagvand *et al.,* 2022**). Seed treatments are an efficient and feasible approach to enhance seed

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viability and seedling vigor (**El-Sanatawy *et al.*, 2021**). Symbiotic nitrogen fixation by legumes has a decisive role in preserving soil fertility and sustaining crop productivity in arid environments. Peanut like other legumes forms a symbiosis relationship with rhizobia (**Bogino *et al.*, 2006**). The most associated role is to promote legume-Rhizobium symbiosis in photo-hormones induce stimulation of root growth, to provide more sites for rhizobia nodulation (**Mahrous *et al.*, 2015**). Gypsum is one of the most primitive forms of fertilizer utilized in peanut production. Gypsum is a relatively soluble source of vital plant nutrients such as calcium and sulfur and can enhance overall plant growth (**Prakash *et al.*, 2020**).it promotes seedling emergence and lessen water filtration rates and movement through the soil profile. It can also diminish losses of nutrients and concentrations of soluble phosphorus in surface water runoff (**Rashmi *et al.*, 2018**).

Diseases cause considerable losses in peanut production (**Naab *et al.*, 2005**). Fungal and bacterial pathogens damage the crop at different stages of growth and cause serious yield losses (**Nazarov *et al.*, 2020**). Though certain plant infections may be managed through resistant genotypes and modification of agricultural practices, various diseases are only managed adequately with the application of an appropriate fungicide (**Jadon *et al.*, 2015**). A suitable means of applying crop protection treatments include treating the seed. Seed treatments can be remarkably effective since they can protect young plants during a sensitive stage in their development (**Ashraf and Foolad, 2005**). Fungicide seed treatment is cheap protection for peanut seed growers and producers. Appropriate fungicide application can provide better performance of plant growth, increasing the seed yield and quality (**Rocha *et al.*, 2019**). Moreover, *Moringa oleifera* extracts had different degrees of antifungal activity against tested pathogens (**El-Mohamedy and Abdalla, 2014**). Moringa extract decreases the opportunity for fungal disease and provides seed vigor and enhances plant growth (**Nwangburuka *et al.*, 2012**).

Genotypes exhibited contrasting performances under different agricultural practices (**Khorami *et al.*, 2018**). Peanut cultivars differed in chemical composition, germination, vigor, fungi infection, and storability (**Bera *et al.*, 2019**). Consequently, the assessment of peanut genotypes to explore those with enhanced efficiency in employing agricultural practices is essential for its future sustainable production (**Putto *et al.*, 2009**). Peanut genotypes display substantial differences in their responses to seed treatments (**Aderiye *et al.*, 2021**). The objective of the present study is to investigate the seed viability and seedling vigor of three peanut cultivars under different seed treatments.

MATERIALS AND METHODS

Experimental Site and Experimental Design

Two field experiments were performed at the Experimental Farm, Faculty of Agriculture, Khattara, Egypt (30° 36′ N, 31° 46′ E) for two scussives summer seasons of 2019 and 2020. The soil is classified as sandy as mean during poth the growing seasons (*i.e.,* 93.34% sand, 2.54% silt, and 4.12% clay). The organic matter and pH were 0.85% and 8.14. Besides, the available nutrients were 19.7 mg N, 10.4 mg P, and 81 mg K, per kg soil. A split plot design with three replications was applied. The evaluated cultivars were allocated in the main plots, while seed treatments were assigned in subplots. The sub-plot area was 9 m^2 (3×3m) which included 4 rows , 75cm apart in width and 3-m long. Sowing took place on May 12^{th} and 19^{th} in the first and the second season, respectively. Calcium superphosphate (15.5% P_2O_5) at a rate of 200 kg/fed and potassium sulfate (48% k_2O) at a rate of 100 kg/fed was added directly after sowing. Nitrogen fertilizer in form of ammonium sulfate (20.5% N) at a rate of 15 kgN/fed was applied at sowing as a starter N dose for boosting plant growth and ensuring uniform plant stands. The other recommended cultural practices for peanut cultivation as drip irrigation, weed and insect control were applied.

Plant Material and Seed Treatments

The evaluated peanut cultivars were Giza-6, North Carolina, and Aramanch. The peanut seeds were separately treated by *Rhizobium* inoculation, moringa leaf extract, Vitavax

(Carboxin 37.5% + Thiram 37.5%), gypsum and Mixture. (Inoculation, Vitavax, Moringa) versus untreated control. Inoculation was applied using an Okadeen as Rhizobium inoculant bag which was well mixed with sugar solution as an adhesive substance and mixed with peanut seeds which were spread on a plastic sheet under shading. The treated seeds by Vitavax was inoculated separately and added alone in a row after sowing. Five hundred grams of moringa leaves were air dried in the open air for 10 days and then were further dried in an air oven at 45^{o}C for two days until constant weight. Dried leaves were ground, sieved, and maintained away from light and moisture until utilized in preparing the extract. The 500 g of the leaves powder were soaked in 1500 ml of the solvent (Ethanol) for four days and filtered through Whatman No.1 filter pepper over Anhydride Sodium Sulphate. Then after, the extract was evaporated by a rotary evaporator (temperature not accessed 50°C). After extraction, the stock solution was prepared, and a dilute solution with a concentration of 2% was prepared. Peanut seeds emerged in moringa ethanol extract, then were sprayed in filter paper for drying and seed moisture content reached 10±2%. The peanut seeds were treated with the recommended dose (2g/kg) of the fungicide Vitavax. The gypsum treatment was applied at the beginning of the flowering stage (around 30 days from sowing) at the rate of 500 kg/fed.

Measured Parameters

Seed oil and protein contents (%)

A sufficient amount of dried peanut seeds was milled to a fine powder. Then, constant samples of dried fine powder were used to determine oil and total nitrogen contents in peanut seeds. Seed oil content was determined using the Soxhlet apparatus and extracted by petroleum ether (60- 80°C) for 12 hour. The total nitrogen was determined using the modified micro Kjeldahl method (**Stuart, 1936**). Total nitrogen was multiplied by 6.25 to obtain crude protein content. Thereafter, oil and crude protein yields/fed were calculated by multiplying their contents by seed yield/fed.

Measurements of seed viability and seedling vigor

These measurements were carried out at the seed laboratory, Faculty of Agriculture, Zagazig University Egypt. Germination tests were performed according to International Seed Testing Association (**ISTA, 1999**). Seeds from each test were germinated at 25°C constant temperature. Germinability was determined using 12 groups each of 25 seeds (a total of 300 seeds) for each treatment. Seeds were placed between double sheets of moistened germination paper toweling. The toweling was folded, and four folded towels were banded together to constitute one 100-seed replication. After seven days, seedling were evaluated and classified as normal (good, fair, poor) or abnormal, dead seedling, dormant seed, and dead seed. The percentage of good seedlings was recorded according to **ISTA (1999).** Germination percentage was calculated using the following equation:

Germination percentage =

$$\frac{\text{Number of germinated seeds}}{\text{Total number of seeds}} \times 100$$

(**Scott *et al*., 1984**).

Germination energy (GE) is the percentage of germinating seeds at three days relative to the number of seeds tested. It was calculated according to the formula outlined by **Alvarado *et al.* (1987)**. GE = ∑ Gi / Ti, where: Gi is the number of seeds germinated on a day and Ti is the number of days. The seeds were considered germinated when the radical was at least 2 mm long. The germination index was calculated using the following formula:

Germination index =

$$\frac{No. of\ germinated\ seed\ (first\ count)}{Days\ of\ first\ count} + \frac{No. of\ germinated\ seed\ (last\ count)}{Days\ of\ final\ count}$$

Germination speed was determined according to the procedure reported by (**Bartlett, 1937**).

$$\text{Germination speed} = \frac{a + (a + b) + (a + b + c) + \ldots\ldots + (a + b + c + m)}{n\ (a + b + c + \ldots\ldots + m)}$$

Where: a, b, c, and m, are the number of seedlings that emerged at the first, second, third, and final count, respectively, (n) the number of counts. During the final count, ten normal seedlings from each replicate were taken randomly to measure the seedling length in cm. The same ten seedlings were dried in a forced air oven at 105°C for 24 hour and weights thereafter. Dry weight recorded and expressed in grams.

Statistical Analysis

The data were subjected to the analysis of variance of split-plot design employing R statistical software version 4.1.1. The differences among evaluated cultivars and seed treatments were separated by Tukey's HSD test ($P \leq 0.05$). **R Core Team (2021)**.

RESULTS AND DISCUSSION

Quality Traits

The assessed peanut cultivars, seed treatments, and their interaction demonstrated a highly significant influence on crude protein content and crude protein yield during both seasons and their combined analysis (Table 1). Cultivar North Carolina ranked first in crude protein content followed by Giza 6 peanut cultivar , Aramanch cultivar was the lowermost crude protein content in both seasons and thrir combined analysis.Allusion to crude protin yield, Giza 6 peanut surpassed significantly the other two cultivars, Aramanch ranked second while North Carolina came at last with the lowest crude protein yield. Results of both seasons and their combined analysis were in concurrence. Concerning the influence of seed treatments, the gypsum treatment followed by moringa extract displayed the highest crude protein content and crude protein yield in the first, second seasons, and the combined analysis. The interaction between peanut cultivars and seed treatments indicates the superiority of Giza-6 and North Carolina treated by most applications in crude protein content over the two growing seasons (Fig. 1). North Carolina treated with gypsum and moringa extract recorded the highest crude protein content. Similarly, Giza-6 treated with the most applications displayed the highest crude protein yield. The highest crude protein yield per feddan was produced by Giza-6 treated with gypsum, and moringa extract.

The evaluated peanut cultivars, seed treatments, and their interaction demonstrated a highly significant influence on oil content and oil yield during both seasons and combined analysis (Table 2). Aramanch peanut cultivar has the highest oil content in both seasons and the pooled analysis , moreover Giza 6 and North Carolina were at par in their oil content in both seasons. Gypsum, and vitavax displayed the highest oil content in both seasons and combined analysis. Regarding oil yield (kg/fed) ,seed treatment with rhizobium inoculation produced the highest oil yield in both seasons and their combined.The interaction between peanut cultivars and seed treatments indicated the superiority of Giza-6 and North Carolina treated by most applications in crude protein content (Fig. 2). North Carolina treated with vitavax recorded the highest crude protein content. Further, Giza-6 treated with the most applications displayed the highest crude protein yield. The highest crude protein yield per feddan was produced by Giza-6 peanut cultivar treated with gypsum and moringa extract.

The evaluated peanut cultivars exhibited highly significant differences in quality traits. These findings indicated the existence of genetic variability in the assessed cultivars which could be exploited for developing high-yielding genotypes. Similarly, **Puangbut *et al.* (2009)**; **Dang *et al.* (2013)**; **El-Far *et al.* (2016)**; **Ajay *et al.* (2020)**; **Patel *et al.* (2021)** and **Wang *et al.* (2022)** exhibited significant differences among peanut genotypes. The applied treatments gypsum, moringa extract, *Rhizobium* inoculation, and Vitavax exhibited considerable enhancement in quality traits compared to untreated control. Gypsum exhibited enhancing impact on the seed quality of peanut (protein and oil contents). In this context, **Gashti *et al.* (2012)** depicted that gypsum has a high solubility in the soil and causes easily releasing and availability of calcium content. Likewise, **Kadirimangalam *et al.* (2022)** proved that gypsum has a positive effect on the absorption of various nutrients such as sulfur and phosphorus which possess vital roles in peanut seed quality. Moreover, gypsum plays a crucial role in seed setting, fertility of peanuts, and increasing seed size which reflects its impact on crude protein and oil yields (**Prakash *et al.*, 2022**). Therefore, it was one of the best treatments for enhancing seed quality. Moringa extract contains various nutrients, antioxidants, and phytohormones (**Nasir *et al.*, 2016**). Additionally, moringa extract could be applied as a seed treatment as a potential alternative to fungicides. Accordingly, moringa extract exhibited a positive impact on the seed

Table 1. Effect of different seed treatments on crude protein content and crude protein yield of three peanut cultivars during two growing seasons (2019 and 2020) and combined analysis

Studied factor	Crude protein content (%)			Crude protein yield (kg/fed)		
	2019	2020	Combined	2019	2020	Combined
Cultivar (C)						
Giza-6	25.03 b	24.99 b	25.01 b	320.61 a	381.39 a	351.00 a
North Carolina	26.59 a	26.26 a	26.43 a	197.55 c	234.67 c	216.11 c
Aramanch	23.55 c	23.74 c	23.65 c	246.96 b	295.84 b	271.40 b
F - test	**	**	**	**	**	**
Seed Treatment (T)						
Inoculation	24.58 c	24.72 c	24.65 c	268.61 b	341.54 a	305.08 ab
Gypsum	27.02 a	26.96 a	26.99 a	289.73 a	355.19 a	322.46 a
Moringa extract	26.13 b	25.89 b	26.01 b	265.62 b	309.05 ab	287.34 b
Vitavax	24.08 cd	23.78 d	23.93 e	234.43cd	272.02 b	253.23 cd
Mixture	24.60 c	24.48 cd	24.54 cd	243.69 c	280.73 b	262.21 c
Control	23.93 d	24.15 cd	24.04 de	228.16 d	265.28 b	246.72 cd
F - test	**	**	**	**	**	**
Interaction						
C×T	**	**	**	**	**	**

Means followed by different letters under the cultivars or seed treatments are significantly different NS: Not significant, * P ≤ 0.05, ** P ≤ 0.01.

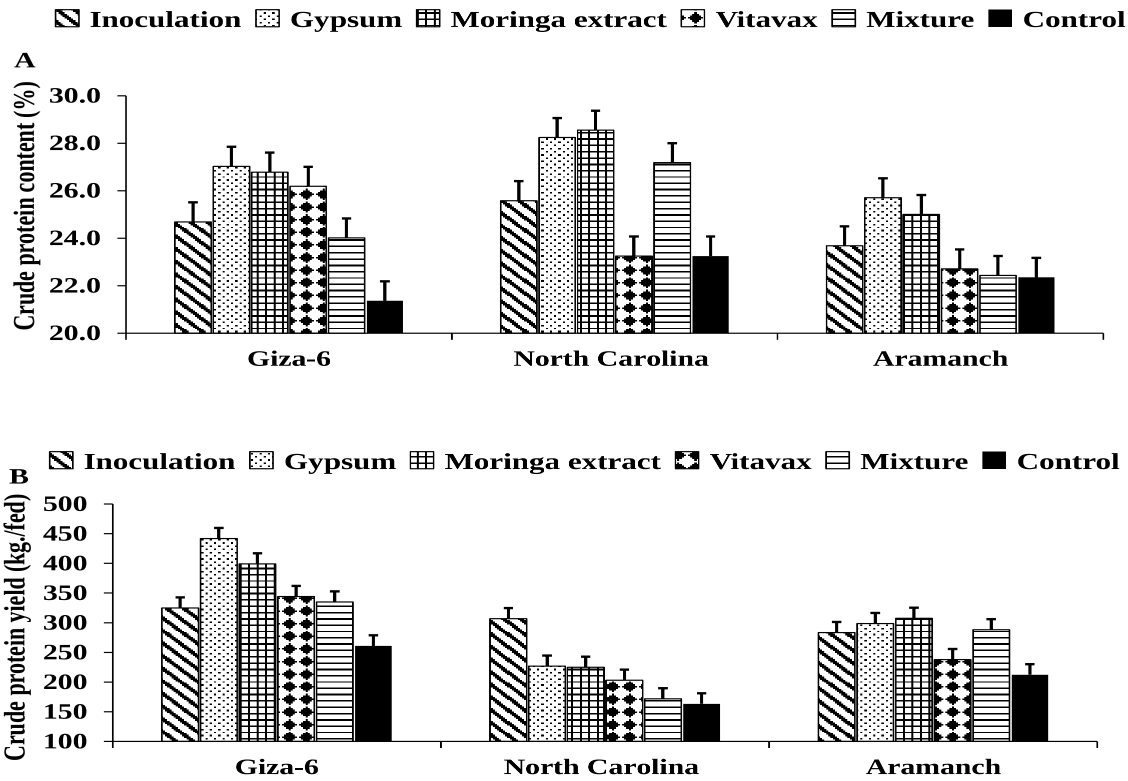

Fig. 1. Impact of seed treatments on crude protein content (A) and crude protein yield per feddan of three peanut cultivars over the two growing seasons. The bars on the columns represent the HSD ($P \leq 0.05$)

Table 2. Effect of different seed treatments on oil content and oil yield of three peanut cultivars during two growing seasons (2019 and 2020) and combined analysis

Studied factor	Oil content			Oil yield (kg/fed)		
	2019	2020	Combined	2019	2020	Combined
Cultivar (C)						
Giza-6	33.93 b	34.02 b	33.97 c	432.57 a	515.72 a	474.146 a
North Carolina	34.51 b	34.33 b	34.42 b	258.88 c	307.89 c	283.384 c
Aramanch	35.48 a	35.52 a	35.50 a	372.05 b	442.21 b	407.131 b
F - test	**	**	**	**	**	**
Seed Treatment (T)						
Inoculation	35.07 ab	34.87 b	34.97 b	383.09 a	480.46 a	431.78 a
Gypsum	35.62 a	35.77 a	35.69 a	385.12 a	475.24 a	430.18 a
Moringa extract	33.77 c	33.73 c	33.75 c	329.09 c	376.97 b	353.04 b
Vitavax	35.66 a	35.71 a	35.68 a	341.25 c	401.87 b	371.56 b
Mixture	34.86 b	34.77 b	34.81 b	357.78 b	409.58 b	383.68 b
Control	32.87 d	32.89 d	32.89 d	330.67 c	387.51 b	359.09 b
F - test	**	**	**	**	**	**
Interaction						
C×T	**	**	**	**	**	**

Means followed by different letters under the cultivars or seed treatments are significantly different. NS: Not significant, * $P \leq 0.05$, ** $P \leq 0.01$.

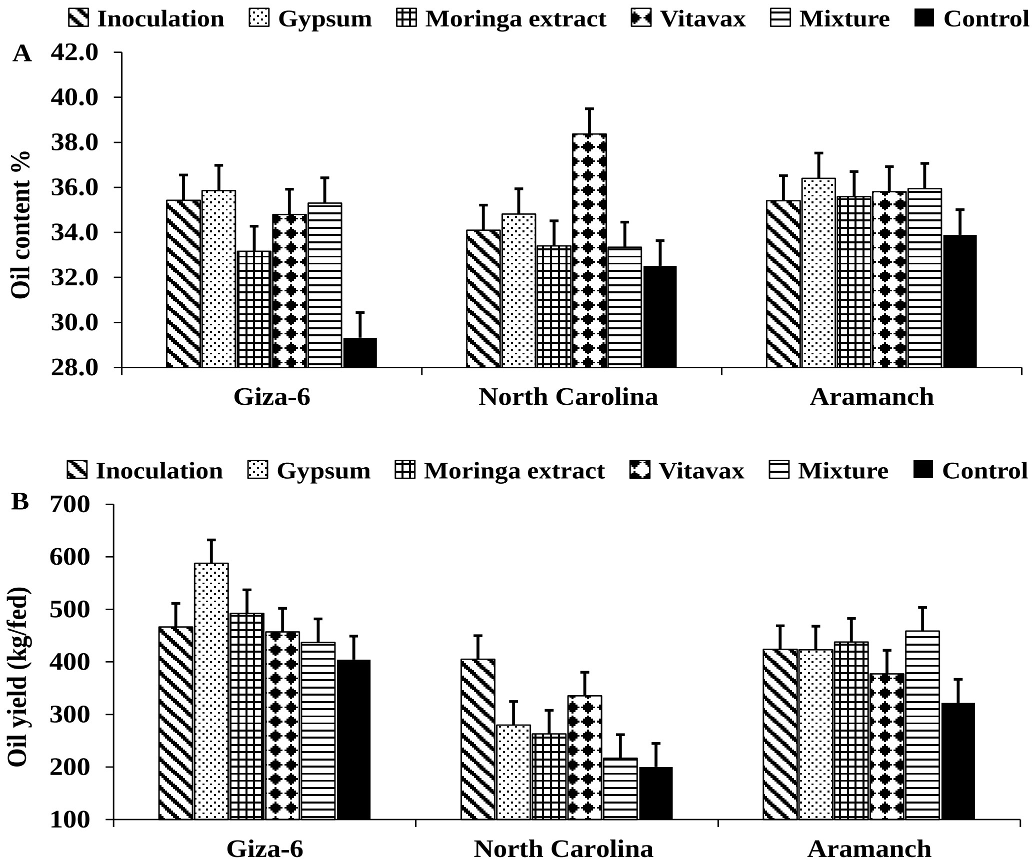

Fig. 2. Impact of seed treatments on oil content (A) and oil yield per fed (B) of three peanut cultivars over the two growing seasons. The bars on the columns represent the HSD ($P \leq 0.05$)

quality traits of peanut. *Rhizobium* inoculation demonstrated positive influences on crude protein and oil contents. In this respect **Radwan (2017)** elucidated that the inoculation fixes atmospheric nitrogen, solubilizes phosphate, synthesizes growth-promoting substances, and boosts the decomposition of plant residues Consequently, *Rhizobium* inoculation boosts soil fertility and in turn, improves seed quality, particularly low fertility soils as our case of study. Peanut is a sensitive crop of fungi causing pre and postemergence damping off. Consequently, in commercial peanut production, the seeds are treated with chemical fungicides to avoid stand losses. In this respect, **Ruark and Shew (2010) and El-Bably *et al.* (2018)** disclosed the ability of Vitavax in improving the seed quality of peanut compared with untreated seed.

Seed Viability and Seedling Vigor

The germination percentage and germination index were substantially affected by varietal differences and seed treatments through the two seasons and their combined as presented in Table 3 and illustrated graphically in Fig. 3. With respect to varietal differences, the result indicated a highly significant difference among peanut cultivars. The cultivar Giza-6 displayed the highest germination percentage, while Armanch achieved the highest germination index during the both seasons and the combined analysis (Table 3). Similarly, seed treatments revealed a highly significant impact on germination percentage and germination index through both seasons and the combined analysis. Vitavax followed by gypsum recorded the highest germination percentage during both seasons and their combined analysis. On the other hand, moringa extract and gypsum achieved the highest germination index. The interaction between peanut cultivars and seed treatments indicates the superiority of Giza-6 treated by all applications in germination percentage (Fig. 3). On the other hand, Aramanch treated with all applications recorded the highest germination index.

Germination speed and germination energy were significantly influenced by varietal differences and seed treatments during both seasons and their combined except germination speed in 2nd season as given in Table (4). The cultivar North Carolina followed by Giza-6 recorded the highest value of germination speed and germination energy. Seed treatments considerably affected germination speed and germination energy during the first season, and the combined analysis. Moringa extract, mixture treatment, and gypsum exhibited the highest values of germination speed and germination energy compared to the other treatments. No significant interaction effect was detected between the studied factors neither through seasons nor in the combined results. Therefore, the interaction results were neglected for germination speed and germination energy.

The percentage of good seedlings and seedling length were affected considerably by varietal differences and seed treatments during both seasons and their combined (Table 5). The cultivar North Carolina followed by Giza-6 recorded the highest values of the percentage of good seedlings during both seasons, and the combined analysis. On the other hand, Aramanch followed by North Carolina exhibited the highest seedling length during both seasons and combined analysis. Concerning the influence of seed treatments on the percentage of good seedlings and seedling length, the results indicated a highly substantial impact during both seasons and the combined analysis. Moringa extract followed by mixture treatment, gypsum, and Vitavax achieved the highest percentage of good seedlings as well as the longest seedling during both seasons and combined analysis.

No significant interaction effect was detected between the studied factors neither through seasons nor in the combined results. Consequently, the interaction results were neglected for the percentage of good seedlings and seedling length.

Seedling fresh and dry weights were significantly influenced by varietal differences and seed treatments during both seasons and the combined analysis as presented in Table 6. North Carolina followed by Aramanch variety possessed the heaviest seedling fresh and dry weights in both seasons and combined analysis. Otherwise, the lightest seedlings' fresh and dry weights were assigned for Giza-6. Concerning the impact of seed treatments, moringa extract followed by mixture treatment, Gypsum and Vitavax exhibited heavier seedling fresh and dry weights in both seasons and combined analysis.

Table 3. Effect of different seed treatments on germination percentage and germination index of three peanut cultivars during two growing seasons (2019 and 2020) and combined analysis

Studied factor	Germination percentage			Germination index		
	2019	2020	Combined	2019	2020	Combined
Cultivar (C)						
Giza-6	98.39 a	98.33 a	98.36 a	6.73 c	6.90 c	6.55 c
North Carolina	82.11 b	85.78 b	83.95 b	7.67 b	7.85 b	7.48 b
Aramanch	82.39 b	85.78 b	84.09 b	8.57 a	8.76 a	8.37 a
F - test	**	**	**	**	**	**
Seed Treatment (T)						
Inoculation	86.22 bc	88.11 c	87.17 cd	7.55 c	7.73 bc	7.36 c
Gypsum	89.33 b	91.44 b	90.39 b	7.73 b	7.90 b	7.56 b
Moringa extract	84.56 c	87.78 c	86.17 d	7.97 a	8.19 a	7.75 a
Vitavax	93.00 a	94.67 a	92.83 a	7.46 cd	7.67 c	7.25 c
Mixture	87.22 bc	89.33 c	88.28 bc	7.74 b	7.86 bc	7.61 b
Control	85.44 c	85.99 d	85.72 cde	7.47 d	7.68 c	7.26 c
F - test	**	**	**	**	**	**
Interaction						
C×T	NS	*	**	NS	NS	NS

Means followed by different letters under the cultivars or seed treatments are significantly different. NS: Not significant, * $P \leq 0.05$, ** $P \leq 0.01$.

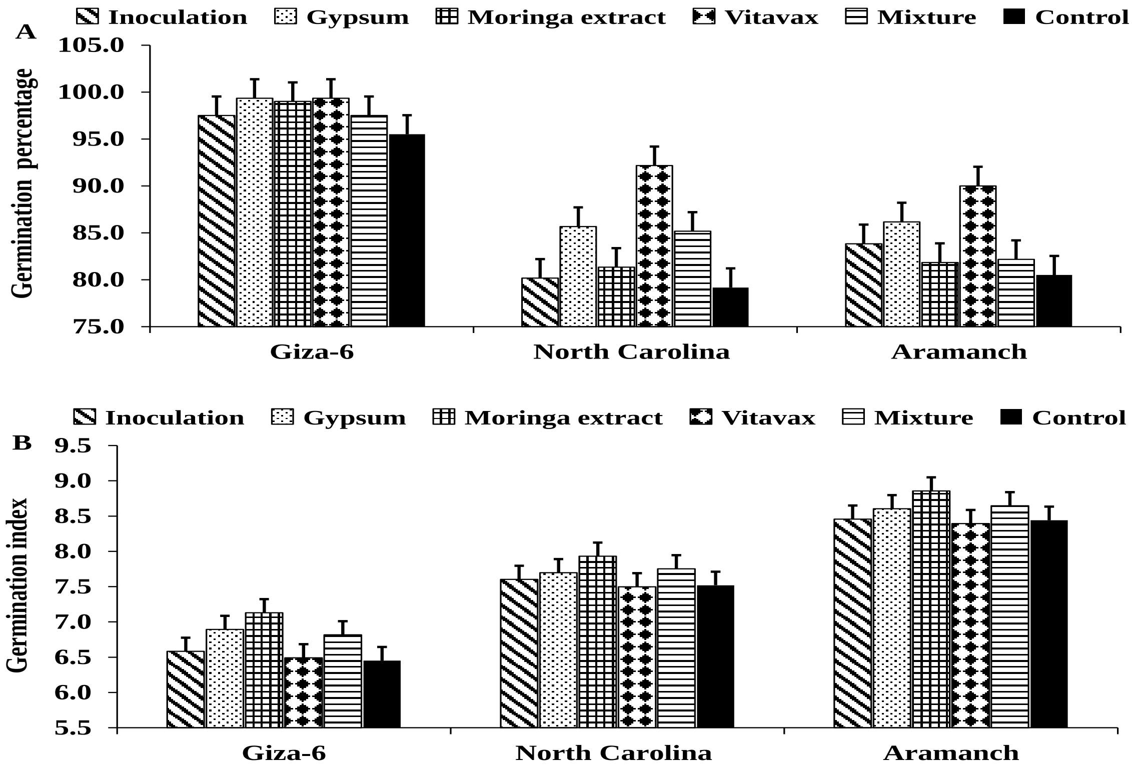

Fig. 3. Impact of seed treatments on germination percentage (A) and germination index (B) of three peanut cultivars over the two growing seasons. The bars on the columns represent the HSD ($P \leq 0.05$)

Table 4. Effect of different seed treatments on germination energy and germination speed per day of three peanut cultivars during two growing seasons (2019 and 2020) and combined analysis

Studied factor	Germination speed			Germination energy		
	2019	2020	Combined	2019	2020	Combined
Cultivar (C)						
Giza-6	0.75 b	0.750	0.749 b	15.08 a	15.41 a	15.25 a
North Carolina	0.76 a	0.750	0.756 a	15.19 a	15.61 a	15.40 a
Aramanch	0.75 b	0.750	0.751 b	13.89 b	14.34 b	14.12b
F - test	**	NS	*	**	**	**
L.S.D (0.05)	0.004	0.009	0.005	0.39	0.61	0.30
Seed Treatment (T)						
Inoculation	0.748 c	0.752	0.751 d	14.63 bc	15.00 b	14.82 c
Gypsum	0.748 c	0.750	0.749 a	14.92 ab	15.37 a	15.15 ab
Moringa extract	0.762 a	0.754	0.758 a	14.98 ab	15.38 a	15.18 a
Vitavax	0.742 d	0.750	0.746 b	14.55 cd	15.02 ab	14.79 c
Mixture	0.755 b	0.755	0.756 a	14.99 a	15.32 ab	15.16 ab
Control	0.751 bc	0.751	0.751 a	14.22 d	14.64 c	14.43 d
F - test	**	NS	**	**	**	**
L.S.D (0.05)	0.005	0.009	0.010	0.36	0.36	0.25
Interaction						
C×T	NS	NS	NS	NS	NS	NS

Means followed by different letters under the cultivars or seed treatments are significantly different at $P \leq 0.05$.
NS: Not significant, * $P \leq 0.05$, ** $P \leq 0.01$.

Table 5. Effect of different seed treatments on the percentage of good seedlings and seedling length of three peanut cultivars during two growing seasons (2019 and 2020) and combined analysis

Studied factor	Percentage of good seedlings			Seedling length (cm)		
	2019	2020	Combined	2019	2020	Combined
Cultivar (C)						
Giza-6	56.89 b	56.74 b	56.82 b	7.02 c	7.43 c	7.23 c
North Carolina	65.69 a	65.97 a	65.83 a	9.01 b	9.43 b	9.22 b
Aramanch	53.32 c	53.75 c	53.54 c	13.33 a	13.81 a	13.57 a
F - test	**	**	**	**	**	**
Seed Treatment (T)						
Inoculation	58.33 bc	58.68 bc	58.33 bcd	9.69 bc	10.04 b	9.87 c
Gypsum	58.20 bc	58.62 bc	58.20 cd	10.02 ab	10.54 a	10.28 ab
Moringa extract	60.18 a	60.02 a	60.18 a	10.27 a	10.67 a	10.47 a
Vitavax	58.63 b	58.91 ab	58.63 bc	9.51 cd	9.93 b	9.72 c
Mixture	59.09 ab	59.18 ab	59.09 b	10.03 ab	10.49 a	10.26 ab
Control	57.37 c	57.48 c	57.37 e	9.20 d	9.69 b	9.45 d
F - test	**	**	**	**	**	**
Interaction						
C×T	NS	NS	NS	NS	NS	NS

Means followed by different letters under the cultivars or seed treatments are significantly different at $P \leq 0.05$.
NS: Not significant, * $P \leq 0.05$, ** $P \leq 0.01$.

Table 6. Effect of different seed treatments on seedling dry weight and seedling fresh weights of three peanut cultivars during two growing seasons (2019 and 2020) and combined analysis

Studied factor	Seedling fresh weight (g)			Seedling dry weight (mg)		
	2019	2020	Combined	2019	2020	Combined
Cultivars (C)						
Giza-6	1.579 c	1.629 b	1.604 c	521 c	561 b	541 b
North Carolina	2.340 a	2.349 a	2.345 a	661 a	690 a	676 a
Aramanch	2.092 b	2.241 a	2.167 b	628 b	669 a	649 a
F - test	**	**	**	**	**	**
Seed Treatments (T)						
Inoculation	1.823 b	2.066 a	1.945 de	595 cd	620 cd	608 cde
Gypsum	2.074 ab	2.115 a	2.095 ab	608 bc	640 bc	624 bc
Moringa extract	2.102 a	2.145 a	2.126 a	634 a	679 a	657 a
Vitavax	2.024 ab	2.075 a	2.050 abcd	589 cd	629 cd	609 cd
Mixture	2.083 ab	2.139 a	2.111 ab	617 ab	662 ab	639 b
Control	1.923 ab	1.898 b	1.911 e	576 d	612 d	594 de
F - test	*	**	**	**	**	**
Interactions						
C×T	NS	NS	NS	NS	NS	NS

Means followed by different letters under the cultivars or seed treatments are significantly different at $P \leq 0.05$.

NS: Not significant, * $P \leq 0.05$, ** $P \leq 0.01$.

Seed viability and seedling establishment are vital stages that greatly impact peanut growth and productivity (**Meena *et al.*, 2022**). Fast and uniform emergence and strong seedlings are prerequisites for strong growth. Vigorous established seedlings have a high capability to compete for resources and interact better with biotic stresses and usually have a higher agronomic performance. The assessed peanut cultivars in the present study exhibited substantial differences in seed viability and seedling vigor. These results revealed the existence of genetic variability in the evaluated cultivars which could be exploited for enhancing the seedling establishment of peanut, particularly under low-fertility sandy soils (**Wang *et al.*, 2022**). Likewise, varietal differences in seed viability and seedling vigor were elucidated in previously published reports by **Janila *et al.* (2013)**; **Ahmed *et al.* (2017)**; **Racette *et al.* (2019)**; **Adebisi (2020)**; **Suassuna *et al.* (2022).**

The detected positive impacts of seed treatments on seed viability and seedling vigor are in consonance with previously published reports. In this respect, **Arnold *et al.* (2017)** pointed out that the gypsum application improved standard germination and seed vigor of both evaluated peanut cultivars (large-seeded Georgia-6G and medium-seed-sized Georgia Greener). Besides, **Priya *et al.* (2019)** disclosed that *Rhizobium* inoculation is an efficient approach for synchronized seed germination and enhanced seedling establishment of peanut. The evaluated rhizobial strain (TNAU-14) exhibited substantial improvement in germination percentage and vigor index. Besides, their results manifested that *Rhizobium* inoculation had a significant effect on the seedling length and root length compared to the untreated control. Moreover, **El-Deriny *et al.* (2018)** disclosed that seed treatments significantly enhanced germination percentage, germination index, electrical conductivity, tetrazolium potential, good seedlings, and fungi infection percentage. The Vitavax application protected seed and attenuated fungi infection percentage followed by moringa leaf extract compared to untreated control. Furthermore, **Sultana *et al.* (2012)** depicted that **s**eed treatment with significantly alleviated the infection percentage of *Cercospora arachidicola* and *Cercosporidium personatum* in peanut.

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تأثير معاملات البذور على جودة البذور، حيوية البذور وقوة البادرات في بعض أصناف الفول السوداني تحت ظروف التربة الرملية

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تعتبر معاملة البذور طريقة قيّمة لتعزيز حيوية البذور وقوة البادرات في الفول السوداني. هذه الدراسة تهدف لتقييم تأثير معاملات بذور المختلفة على حيوية البذور وقوة البادرات لثلاثة أصناف من الفول السوداني (جيزة ٦ ونورث كارولينا وأرامانش) معاملات البذور التي تم استخدامها كانت التلقيح البكتيري، الجبس، مستخلص أوراق المورينجا والفيتافاكس مقارنة بمعاملة الكنترول غير المعاملة. تباينت أصناف الفول السوداني التي تم تقييمها بشكل كبير في صفات الجودة، حيوية البذور، وقوة البادرات. سجل الصنفان نورث كارولينا وجيزة ٦ أعلى محتوى بروتين، سرعة إنبات، طاقة إنبات، نسبة بادرات جيدة في كلا الموسمين والتحليل المجمع. علاوة على ذلك، سجل الصنفين أرامانش وجيزة ٦ أعلى محتوى زيت، نسبة إنبات، دليل إنبات، طول البادرة، وزن البادرة الغض ووزن البادرة الجاف خلال الموسمين والتحليل المجمع. كذلك معاملات البذور التي تم استخدمها أظهرت تحسين معنوي في صفات جودة الفول السوداني، حيوية البذور، وقوة البادرات. أظهر الجبس ويليه مستخلص المورينجا، التلقيح البكتيري والفيتافاكس أعلى محتوى بروتين، نسبة زيت، نسبة إنبات، دليل إنبات، سرعة إنبات، طاقة إنبات، نسبة بادرات جيدة، طول بادرات وأوزان بادرات غضة وجافة في كلا الموسمين التحليل المجمع. لذلك يعد المعاملة بالجبس، مستخلص المورينجا، التلقيح البكتيري، أو الفيتافاكس اتجاه فعالًا لتعزيز جودة البذور، حيوية البذور وقوة بادرات للأصناف المختلفة من الفول السوداني.

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