Science World Journal Vol. 19(No 3) 2024 https://dx.doi.org/10.4314/swj.v19i3.22
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

Full Length Research Article

IMPACT OF HYDRO-PRIMING DURATIONS ON VIABILITY, GROWTH AND SEED YIELD OF TWO RICE (*Oryza sativa*) VARIETIES

*[1]Tandoh P.K., [1]Idun I.A., [2]Aculey P., [2]Adu E. and [1]Osam Y.N.

[1]Department of Horticulture, Kwame Nkrumah University of Science and Technology
[2]Crops Research Institute of Ghana-CSIR, Fumesua

*Corresponding Author Email Address: pktandoh.canr@knust.edu.gh Phone: +233243237465

ABSTRACT
Rice is one of the world's main staple crops with nearly 2.5 billion people depending on it for food. However, seed germination becomes very difficult and erratic a short period of time after harvesting. The objective of this study was to determine the effects of hydro-priming durations on germination, growth and seed yield of two rice varieties (Jasmine 85 and Amankwatia). The experimental design was 2x3 factorial arrangement in Randomized Complete Block Design with three replications. Factor one was two varieties (Amankwantia and Jasmine 85) and factor two was three hydro-priming durations (24 hours, 48 hours and no priming). The study revealed that seeds which were hydro-primed for 24 and 48 hours took shorter days to emerge. Amankwatia variety which was hydro-primed for 24 hours gave the highest germination percentage and vigour index. Highest tiller numbers at week eleven and tallest plants measured at sixth, ninth, tenth and eleventh weeks after sowing were produced by Amakwatia variety which was not hydro-primed. Highest number of leaves at six, eight and nine weeks after sowing as well as number of tillers at weeks ten were produced by Jasmine 85 variety which was hydro-primed for 48 hours. Additionally, highest number of productive panicles and the resultant seed yield were produced by Jasmine 85 variety which were hydro-primed for 48 hours. A relationship analysis showed that there was strong significant and negative correlation between number of productive panicles and unproductive panicles as well as a strong significant and positive correlation between seed yield and productive panicles. Number of productive panicles significantly affected seed yield such that 82% of variation in the seed yield was attributed to the productive panicles. The study concluded that to obtain highest viability, best growth and resultant seed yield, Jasmine 85 variety hydro-primed for 48 hours should be highly considered.

Keywords: Radicle, protrusion, elongation, heading, emergence, vigour, dry matter

INTRODUCTION

Rice is the predominant staple food meeting over 25% of the calorific needs of half of the world's population (Kusano *et al.,* 2015). According to a report by FAO (2021), over 755 million tons of rice was produced in 143 countries. Rice contributes significantly to food security since more than half of the world's population utilizes it as a primary staple food, the main source of energy and income (Fikriyah 2018). In Ghana, rice has become the most important staple food after maize and there has been an increase in rice consumption due to increased population growth, change in consumer preference and urbanization. In the year 2020, the harvested rice production area and yield were 973,000 tonnes, 331,471 ha, and 29,354 kg/ha (Ackaah *et al*., 2023; FAO, 2020). Furthermore, Ghana spends about $450 million on rice imports to make up for the shortfall in supply and thus imports about 50% of its rice needs annually (Adomako *et al*., 2020; Ragasa and Chapoto, 2017; Asante *et al*., 2013). In Ghana, rice comes second to maize and accounts for 16% of all cereal production (Francic and Tran, 2018). Due to its ease of preparation and shifting consumer preferences, especially in urban areas, rice is increasingly replacing traditional Ghanaian staples like plantains, sorghum, and millet. The husk of rice can be used to feed animals as well as a source of fuel and in biochar preparation. In developing countries, rice serves as the most important crop and plays a major role in poverty alleviation and food security attainment as stated in the first objective of the Sustainable Development Goals (SDGs) for 2030 (Ackaah *et al*., 2023).

In spite of the numerous benefits obtained from rice production, germination of rice seed is very difficult especially when sowing it directly on the field. This condition is known to be caused by the onset of dormancy just a few period of time after harvesting. Dormancy in rice seed is imposed by certain physical and chemical factors associated with its covering structures, i.e., hull and pericarp (Sheshu and Dadlani, 1991). Prolonged seed dormancy can lead to over poor germination, less vigorous seedlings and low yield. The underlying mechanisms by which seed priming enhances germination are likely to be a result of moderate hydration to a level where pre-germination metabolic processes begin without actual germination (Zulfiqar, 2021) Seed priming treatments can lead to better germination and establishment in many fields crop such as maize, wheat and rice. Different agronomic properties of okra such as number of days taken to 50% flowering, seedling growth, fruit length, and total yield per plant increased as a result of hydro-priming (Kaur *et al*, 2015). There is little research information on how hydro-priming durations influence the viability, growth and seed yield of these selected rice varieties which are predominantly grown in Ghana. The objective of this study was to determine the effect of hydro-priming durations on the germination, growth characteristics and yield of two rice varieties Jasmine 85 and Amankwatia

MATERIAL AND METHODS

EXPERIMENTAL SITE

This experiment was carried out at the Department of Horticulture, Kwame Nkrumah University of Science and Technology. The site is within an elevation of 186 m above sea level (ASL) and is in the semi-deciduous forest zone. The rainfall distribution pattern is bimodal where the major rainy season falls between ending of March to middle of July. The major season is from mid-July to mid-September whiles the minor rainy season from mid-September to mid-November with mean values of 21^{0}C and 31^{0}C respectively, are minimum and maximum temperatures with 1500 mm and 95%

Science World Journal Vol. 19(No 3) 2024 https://dx.doi.org/10.4314/swj.v19i3.22
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

as mean annual rainfall, and mean annual relative humidity respectively. Ferric Acrisol soil is the main soil type at the experimental site.

EXPERIMENTAL DESIGN

The experimental design was 2x3 Factorial arrangement in Randomized Complete Block Design with three replications. Factor one was two varieties of rice (Amankwatia and Jasmine 85) and factor two was hydro-priming durations at three levels (24 hours, 48 hours and no hydro-priming). The rice seed samples were obtained from the Crops Research Institute (CRI), Kumasi, Ghana. Seeds were sown in nursery trays in the plant house at the Department of Horticulture. The trays were filled with well decomposed cocopeat which was used as the media. The seeds were sown on 23rd May, 2023 at the rate of one seed per hole. The seeds were slightly covered with the cocopeat and watered regularly. After 7 days of sowing, germination was evaluated.

Preparation of plastic basins for planting and transplanting

Sieved top soil was put in a metal container tray and steam-sterilized for 3 hours at 100ºC. The sterilized soil was then spread on a large tarpaulin, covered and left overnight to cool. 21.3 kg of the cooled sterilized soil was weighed and put in plastic buckets measuring 60 cm (diameter) x 70 cm (height). Drainage holes were created on each of the basins for drainage of water. To allow the soil to settle prior to transplanting, thorough watering was then done. Transplanting was done on 16th June, 2023 and then watered. a hand fork was used to stir the soil to enhance soil aeration at fortnight interval. Three weeks after transplanting, (NPK 15-15-15) fertilizer was applied to the seedlings at a rate of 8 g per plant. Watering was done judiciously in the mornings and late afternoons. Weed control was done by handpicking at two weeks interval.

The following parameters were taken:

Seed germination percentage

Hundred (100) seeds from the pure seed fraction of each treatment were used to conduct the germination test. The seeds were arranged in four replications of 70 each on a counting board. Each replicate was subsequently planted in a levelled layer of moist sand in a perforated container. The first germination count was done on the 5th day. On the 8th day seedlings in each replicate were counted and grouped into normal, abnormal, fresh un-germinated and dead seeds. Germination was indicated by the proportion of seeds that had produced normal seedlings under the conditions and within the eight-day period (ISTA, 2007). The percentage germination was calculated using the following formula:

$$GP\% = \frac{number\ of\ germinated\ seeds}{number\ of\ viable\ seeds} \times 100\%$$

Seedling vigour index

At two weeks after germination, the shoot length and root length of 10 seedlings were measured using a metre rule, for each of the three replicates and the average computed. The vigour index was calculated using the formula of Abdul-Baki and Anderson (1973) as follows:

Vigour Index = (Shoot length + Root length) x Germination Percentage

Plant height (cm) – using a meter rule the height of the plants were measured from the soil level to the apex.

Number of leaves

This was done by counting the green and functional leaves on each of the ten plants and the mean per plant recorded.

Number of tillers

Tillers number were counted and recorded.

Number of productive and unproductive panicles

The number of productive and unproductive panicles were counted and recorded.

***Seed yield* (weight)**

Using a digital scale, weight of seeds harvested from each treatment was weighed and recorded.

ANALYSIS OF DATA

Using the Statistix Software Version 10.0, data collected was subjected to Analysis of Variance (ANOVA). Treatment mean differences were separated using Tukey's Honestly Significant Difference (HSD) at 5% probability level.

RESULTS

Effect Of Hydro-Priming Durations on Number O of Days to Emergence of Jasmine 85 and Amankwatia Rice Varieties

The interaction between hydro-priming durations and varieties were statistically not significant ($p \geq 0.05$) for number of days to emergence. However, there were differences in the means of the hydro-priming durations (Figure 1). Seeds which were primed for 24 and 48 hours took shorter days to emerge (5.3 days) and the unprimed seeds took longer days to emerge (7.5 days).

Science World Journal Vol. 19(No 3) 2024 https://dx.doi.org/10.4314/swj.v19i3.22
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

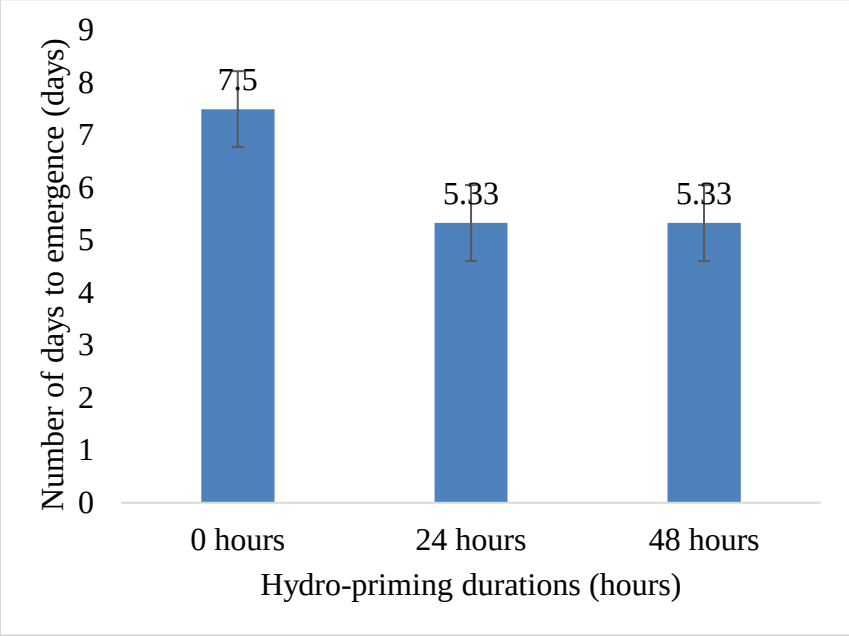

Figure 1: Influence of hydro-priming durations on number of days to emergence

Germination Percentage of Jasmine 85 and Amankwatia Rice Varieties as Affected by Hydro-Priming Durations

The interaction between hydro-priming durations and varieties were statistically significant ($p \leq 0.05$) for germination percentage (Table 1). Amankwatia rice variety which was hydro-primed for 24 hours recorded the highest germination percentage (84.67%) and the least (67.33%) was recorded by Jasmine 85 variety which was not hydro-primed. For the hydro-priming durations only, the significantly highest germination percentage (78.83%) was seeds hydro-primed for 48 hours and the least was those not hydro-primed (70.83%). With respect to the varieties, Amankwatia recorded the highest germination percentage (78.78%) and the least (72.67%) was Jasmine 85.

Table 1: Effect of hydro-priming durations on germination percentage of Jasmine 85 and Amankwatia rice varieties

	Varieties		
Hydro-priming Durations	Jasmine 85	Amankwatia	Means
0 hours	67.33^{f}	74.33^{d}	70.83^{c}
24 hours	70.33^{e}	84.67^{a}	77.50^{b}
48 hours	80.33^{b}	77.33^{c}	78.83^{a}
Means	72.67^{b}	78.78^{a}	
HSD (0.05): Varieties=0.495, Hydro-priming durations=0.747 Varieties* Hydro-priming durations=1.335			

Footnote: HSD: Honest significant difference at 5% probability level; Means followed by the same letter(s) within a treatment group are not significantly different at 5% level of probability using Duncan Multiple Range Test (DMRT).

Vigour Index of Jasmine 85 and Amankwatia Rice Varieties as Affected by Hydro-Priming Durations

The interaction between hydro-priming durations and varieties were statistically significant ($p \leq 0.05$) for vigour index (Figure 1-3). Amankwatia rice variety which was hyrdoprimed for 24 hours recorded the highest vigour index (4839.6) and the least (3156.20) was recorded by Jasmine 85 variety which was not hydro-primed (Figure 2). For the hydro-priming durations only, significantly highest vigour index (4323.40) was recorded by seeds hydro-primed for 48 hours and the least (3510.00) was those not hydro-primed (Figure 3). With respect to the varieties, Amankwatia recorded the highest vigour index (4289.9) and the least (3689.2) was Jasmine 85 (Figure 4).

Science World Journal Vol. 19(No 3) 2024 https://dx.doi.org/10.4314/swj.v19i3.22
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

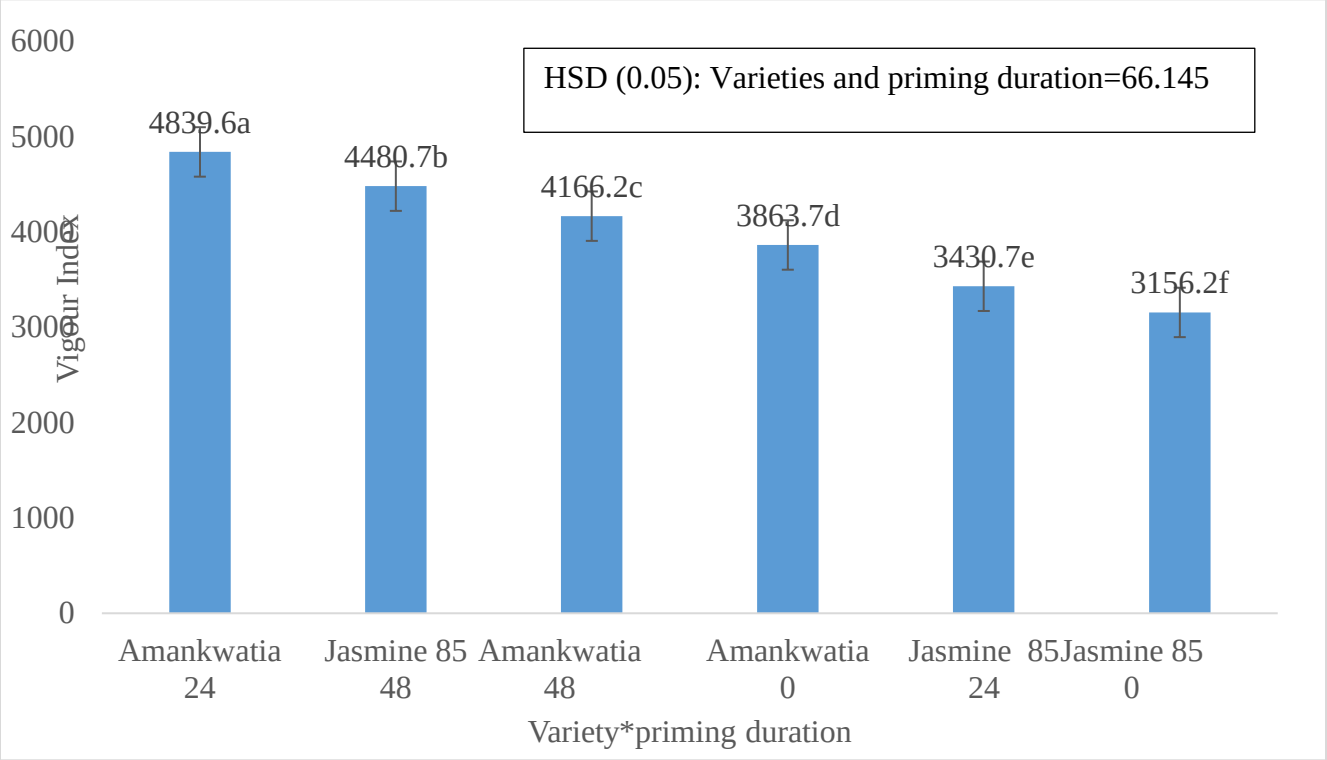

Figure 2: Vigour index of Jasmine and Amakwatia varieties as influenced by hydro-priming durations

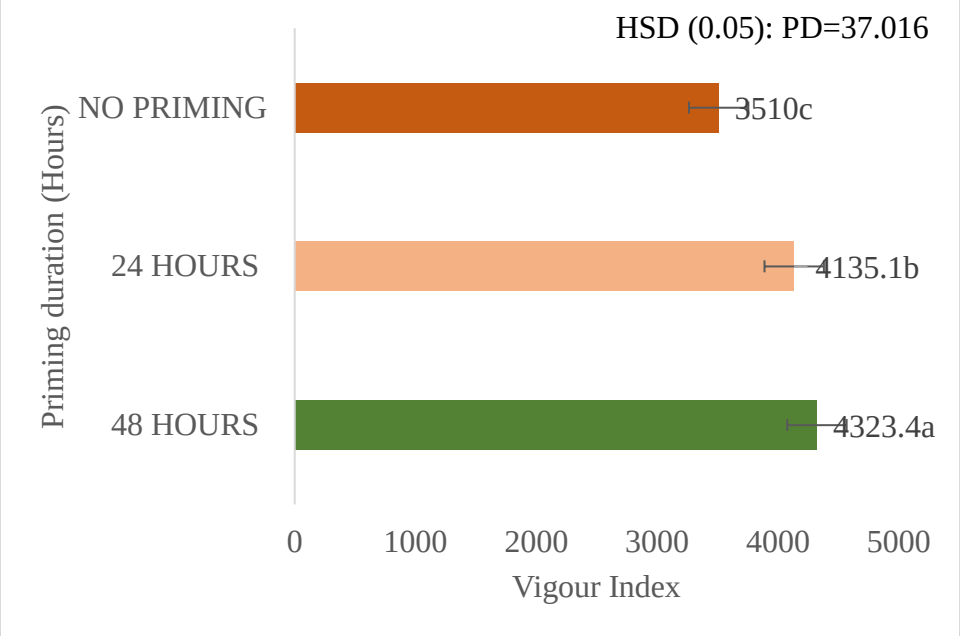

Figure 3: Influence of priming durations on vigour index of rice

Science World Journal Vol. 19(No 3) 2024 https://dx.doi.org/10.4314/swj.v19i3.22
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

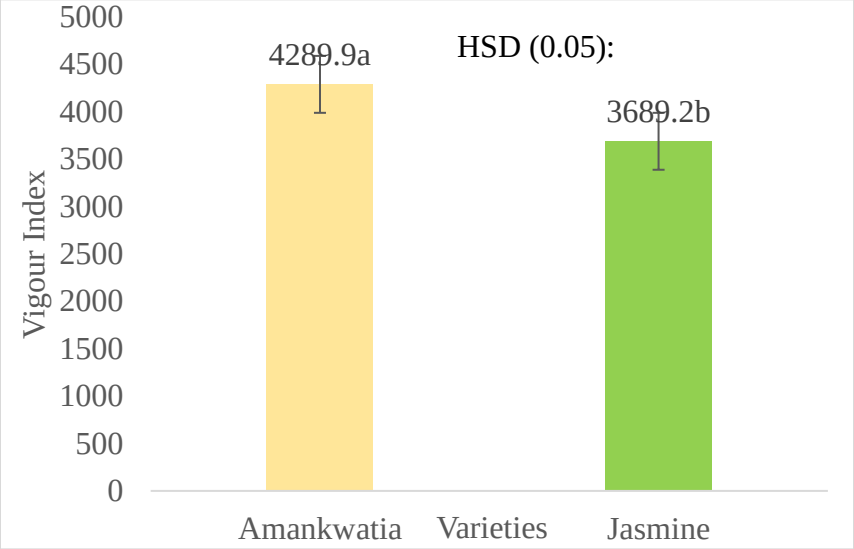

Figure 4: Vigour index of Jasmine and Amakwatia varieties

Plant Height of Jasmine 85 and Amankwatia Rice Varieties at Six Weeks After Sowing as Affected by Hydro-Priming Durations

The interaction between hydro-priming durations and varieties were statistically significant ($p \leq 0.05$) for plant height at six weeks after sowing (Table 2). Both Jasmine 85 and Amankwatia rice varieties which were not hydro-primed recorded the tallest plants (32.67 cm and 32.40 cm) and the shortest (24.50 cm) was recorded by Jasmine 85 variety which was hydro-primed for 24 hours and was similar to Amakwatia variety hydro-primed for 48 hours (27.07 cm). For the hydro-priming durations only, the highest plant height (32.53 cm) was the seeds that was not hydro-primed and the least (27.08 cm) was those that was hydro-primed for 12 and 24 hours. With respect to the varieties, there existed no significant differences between them.

Table 2: Plant height (cm) of Jasmine 85 and Amankwatia rice varieties at six weeks after sowing as affected by hydro-priming durations

	Varieties		
Hydro-priming Durations	Jasmine 85	Amankwatia	Means
0 hours	32.67^{a}	32.40^{a}	32.53^{a}
24 hours	24.50^{c}	29.67^{ab}	28.80^{b}
48 hours	30.53^{ab}	27.07^{c}	27.08^{b}
Means	29.23^{a}	29.71^{a}	
HSD (0.05): Varieties=1.732, Hydro-priming durations=2.611 Varieties* Hydro-priming durations=4.666			

Plant Height of Jasmine 85 and Amankwatia Rice Varieties at Eight Weeks After Sowing as Affected by Hydro-Priming Durations

There were no significant hydro-priming and varieties interaction for plant height at eight weeks after sowing. For the hydro-priming durations only, the tallest plants were produced by the seeds that were not hydro-primed and the shortest were those that were hydro-primed for 24 hours. With respect to the varieties, there existed no significant differences between them (Table 3).

Table 3: Plant height (cm) of Jasmine 85 and Amankwatia rice varieties at eight weeks after sowing as affected by hydro-priming durations

Varieties			
Hydro-priming Durations	Jasmine 85	Amankwatia	Means
0 hours	50.50^{a}	48.33^{a}	49.42^{a}
24 hours	46.33^{a}	47.67^{a}	47.00^{b}
48 hours	49.67 ^{a}	48.50^{a}	49.08^{ab}
Means	48.83^{a}	48.17^{a}	
HSD (0.05): Varieties=1.547, Hydro-priming durations=2.332, Varieties* Hydro-priming durations=4.167			

Science World Journal Vol. 19(No 3) 2024 https://dx.doi.org/10.4314/swj.v19i3.22
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

Plant Height of Jasmine 85 and Amankwatia Rice Varieties at Nine Weeks After Sowing as Affected by Hydro-Priming Durations

The interaction between hydro-priming durations and varieties were statistically significant ($p \leq 0.05$) for plant height at nine weeks after sowing (Table 4). Amankwatia rice variety which was not hydro-primed recorded the tallest plants (61.90 cm) and it was similar to those hydro-primed for 24 hours (60.13 cm). The shortest plants were produced by Amankwatia variety which was primed for 48 hours (54.87 cm). For the hydro-priming durations only, the tallest plants were produced by seeds which were not primed (60.60 cm) and the shortest were those that were hydro-primed for 48 and 24 hours. With respect to the varieties, there existed no significant differences between them.

Table 4: Plant height (cm) of Jasmine 85 and Amankwatia rice varieties at nine weeks after sowing as affected by hydro-priming durations

Varieties			
Hydro-priming Durations	Jasmine 85	Amankwatia	Means
0 hours	59.30^{abc}	61.90^{a}	60.60^{a}
24 hours	55.67^{bc}	60.13^{a}	57.90^{b}
48 hours	59.67^{ab}	54.87^{c}	57.27^{b}
Means	58.21^{a}	58.97^{a}	
HSD (0.05): Varieties=1.658, Hydro-priming durations=2.499, Varieties* Hydro-priming durations=4.465\			

Plant Height of Jasmine 85 and Amankwatia Rice Varieties at Ten Weeks After Sowing as Affected by Hydro-Priming Durations

The interaction between hydro-priming durations and varieties were statistically significant ($p \leq 0.05$) for plant height at ten weeks after sowing (Table 5). Amankwatia rice variety which was not hydro-primed produced the tallest plants (80.93 cm) which was similar to Amankwatia which was hydro-primed for 24 hours (80.33 cm). and the shortest (71.87 cm) was produced by Jasmine 85 variety which was not primed which was similar to Amankwatia variety hydro-primed for 48 hours (72.07 cm). For the hydro-priming durations only, the tallest plants (78.50 cm) were produced by the seeds that were hydro-primed for 24 hours which was similar to those which were not primed (76.40 cm) and the shortest were those that were hydro-primed for 48 hours (73.53 cm). With respect to the varieties, there were no significant differences between them.

Table 5: Plant height (cm) of Jasmine 85 and Amankwatia rice varieties at ten week after sowing as affected by hydro-priming durations

Varieties			
Hydro-priming Durations	Jasmine 85	Amankwatia	Means
0 hours	71.87^{c}	80.93^{a}	76.40^{a}
24 hours	76.67^{ab}	80.33^{a}	78.50^{a}
48 hours	75.00^{bc}	72.07^{c}	73.53^{b}
Means	74.51^{a}	77.78^{a}	
HSD (0.05): Varieties=1.605, Hydro-priming durations=2.421, Varieties* Hydro-priming durations=4.326			

Plant Height of Jasmine 85 and Amankwatia Rice Varieties at Eleven Weeks After Sowing as Affected by Hydro-Priming Durations

The interaction between hydro-priming durations and varieties were statistically significant ($p \leq 0.05$) for plant height at eleven weeks after sowing (Table 6). Amankwatia rice variety which was not hydro-primed recorded the tallest plants (83.33 cm) and the shortest (71.83 cm) was recorded by Jasmine 85 variety which was hydro-primed for 48 hours. For the hydro-priming durations only, the tallest plants were produced by the seeds that were not hydro-primed (79.25 cm) which was similar to seeds which were hydro-primed for 24 hours and the shortest were those that were hydro-primed for 48 hours (72.25 cm). With respect to the varieties, Amankwatia recorded the tallest plants (78.00 cm) and the least was Jasmine 85 (74.89 cm).

Table 6: Plant height (cm) of Jasmine 85 and Amankwatia rice varieties at eleven weeks after sowing as affected by hydro-priming durations

Varieties			
Hydro-priming Durations	Jasmine 85	Amankwatia	Means
0 hours	75.17^{bcd}	83.33^{a}	79.25^{a}
24 hours	77.67^{bc}	78.00^{b}	77.83^{a}
48 hours	71.83^{d}	72.67^{cd}	72.25^{b}
Means	74.89^{b}	78.00^{a}	
HSD (0.05): Varieties=1.94, Hydro-priming durations=2.928, Varieties* Hydro-priming durations=5.231			

Number of Leaves of Jasmine 85 and Amankwatia Rice Varieties at Six Weeks After Sowing as Affected Hydro-Priming Durations

The interaction between hydro-priming durations and varieties were statistically significant ($p \leq 0.05$) for number of leaves at six weeks after sowing (Table 7). Jasmine 85 rice variety which was

Science World Journal Vol. 19(No 3) 2024 https://dx.doi.org/10.4314/swj.v19i3.22
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

hydro-primed for 48 hours recorded the highest number of leaves (46.33) and the least was recorded by Amankwatia rice variety which was hydro-primed for 48 hours (21.00). For the hydro-priming durations only, the significantly highest number of leaves was the seeds that were hydro-primed for 48 hours (33.67) and the least was those that were hydro-primed for 24 hours (25.17). With respect to the varieties, Jasmine 85 recorded the highest number of leaves (36.00) and the least was Amankwatia (23.56).

Table 7: Number of leaves of Jasmine 85 and Amankwatia rice varieties at six weeks after sowing as affected hydro-priming durations

Varieties			
Hydro-priming Durations	Jasmine 85	Amankwatia	Means
0 hours	35.33^{b}	25.67^{c}	30.50^{b}
24 hours	26.33^{c}	24.00^{cd}	25.17^{c}
48 hours	46.33^{a}	21.00^{d}	33.67^{a}
Means	36.00^{a}	23.56^{b}	
HSD (0.05): Varieties=1.177, Hydro-priming durations=1.775, Varieties* Hydro-priming durations=3.172			

Number of Leaves of Jasmine 85 and Amankwatia Rice Varieties at Eight Weeks After Sowing Hydro-Priming Durations

The interaction between hydro-priming durations and varieties were statistically significant ($p \leq 0.05$) for number of leaves at eight weeks after sowing (Table 8). Jasmine 85 rice variety which was hydro-primed for 48 hours recorded the largest number of leaves (21.00) which was similar to Amankwatia variety which was not hydro-primed (19.67) and the least was recorded by Amankwatia rice variety which was primed for 24 hours. For the hydro-priming durations only, the significantly highest number of leaves was the seeds that was not hydro-primed (18.17) and the least was those that was hydro-primed for 24 hours (12.00). With respect to the varieties, Jasmine 85 recorded the highest number of leaves (16.78) and the least was Amankwatia (14.22).

Table 8: Number of leaves of Jasmine 85 and Amankwatia rice varieties at eight weeks after sowing hydro-priming durations

Varieties			
Hydro-priming Durations	Jasmine 85	Amankwatia	Means
0 hours	16.67^{b}	19.67^{a}	18.17^{a}
24 hours	12.67^{c}	11.33^{c}	12.00^{c}
48 hours	21.00^{a}	11.67^{c}	16.33^{b}
Means	16.78^{a}	14.22^{b}	
HSD (0.05): Varieties=1.102, Hydro-priming durations=1.662, Varieties* Hydro-priming duration =2.969			

Number of Leaves of Jasmine 85 and Amankwatia Rice Varieties at Nine Weeks After Sowing as Affected by Hydro-Priming Durations

The interaction between hydro-priming durations and varieties were statistically significant ($p \leq 0.05$) for number of leaves at nine weeks after sowing (Table 9) Jasmine 85 rice variety which was not hydro-primed recorded the highest number of leaves (6.67) and the least was recorded by Jasmine 85 rice variety which was primed for 24 hours (4.33). For the hydro-priming durations only, the highest number of leaves was the seeds that was not hydro-primed (5.67) and the least were those that was hydro-primed for 24 hours (4.67). With respect to the varieties, Jasmine 85 recorded the highest number of leaves (5.56) and the least was Amankwatia (4.78).

Table 9: Number of leaves of Jasmine 85 and Amankwatia rice varieties at nine weeks after sowing as affected by hydro-priming durations

Varieties			
Hydro-priming Durations	Jasmine 85	Amankwatia	Means
0 hours	6.67^{a}	4.67^{bc}	5.67^{a}
24 hours	4.33^{c}	5.00^{bc}	4.67^{b}
48 hours	5.67^{ab}	4.67^{bc}	5.17^{ab}
Means	5.56^{a}	4.78^{b}	
HSD (0.05): Varieties=0.470, Hydro-priming durations=0.709, Varieties* Hydro-priming duration =1.266			

Number of Tillers of Jasmine 85 and Amankwatia Rice Varieties at Eight Weeks After Sowing as Affected By Hydro-Priming Durations

There were no significant hydro-priming and varieties interaction for number of tillers eight weeks after sowing (Table 10).

Science World Journal Vol. 19(No 3) 2024 https://dx.doi.org/10.4314/swj.v19i3.22
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

Table 10: Number of tillers of Jasmine 85 and Amankwatia rice varieties at eight weeks after sowing as affected by hydro-priming durations

Varieties			
Hydro-priming Durations	Jasmine 85	Amankwatia	Means
0 hours	5.33^{a}	4.67^{a}	5.00^{a}
24 hours	4.33^{a}	3.67^{a}	4.00^{a}
48 hours	5.67^{a}	4.67^{a}	5.17^{a}
Means	5.11^{a}	4.33^{a}	
HSD (0.05): Varieties=0.851, Hydro-priming durations=1.283, Varieties* Hydro-priming duration =2.292			

Tillers of Jasmine 85 and Amankwatia Rice Varieties at Ten Weeks After Sowing as Affected by Hydro-Priming Durations

The interaction between hydro-priming durations and varieties were statistically significant ($p \leq 0.05$) for number of tillers at ten weeks after sowing (Table 11). Jasmine 85 rice variety which was hydro-primed for 48 hours recorded the largest number of tillers (10.67) which was similar to Amankwatia variety which were hydro-primed for 24 hours and were not hydro-primed and the least was recorded by Jasmine 85 rice variety which was primed for 24 hours (6.33). For the hydro-priming durations only, the highest number of tillers was the seeds that was hydro-primed for 48 hours (10.00) and the least was those that was hydro-primed for 24 hours (8.17). With respect to the varieties, Amankwatia recorded the highest number of tillers (9.89) the least was Jasmine 85 (8.22).

Table 11: Effect of hydro-priming durations on number of tillers of Jasmine 85 and Amankwatia rice varieties at ten weeks after sowing

Varieties			
Hydro-priming Duration	Jasmine 85	Amankwatia	Means
0 hours	7.67^{bc}	10.33^{a}	9.00^{ab}
24 hours	6.33^{c}	10.00^{a}	8.17^{b}
48 hours	10.67^{a}	9.33^{ab}	10.00^{a}
Means	8.22^{b}	9.89^{a}	
HSD (0.05): Varieties=0.851, Hydro-priming durations=1.283, Varieties* Hydro-priming duration =2.292			

Number of Tillers of Jasmine 85 and Amankwatia Rice Varieties at Eleven Weeks After Sowing as Affected By Hydro-Priming Durations

The interaction between hydro-priming durations and varieties were statistically significant ($p \leq 0.05$) for number of leaves at eleven weeks after sowing (Table 12). Amankwatia rice variety which was not hydro-primed recorded the largest number of tillers (14.33) and the least was recorded by Amankwatia rice variety which was hydro-primed for 48 hours (11.00). For the hydro-priming durations only, there were no significant differences. With respect to the varieties, Amankwatia did not differ Jasmine 85.

Table 12: Effect of hydro-priming durations on number of tillers of Jasmine 85 and Amankwatia rice varieties at eleven weeks after sowing

Varieties			
Hydro-priming Durations	Jasmine 85	Amankwatia	Means
0 hours	12.67^{ab}	14.33^{a}	13.50^{a}
24 hours	11.67^{b}	13.00^{ab}	12.33^{a}
48 hours	13.33^{ab}	11.00^{b}	12.17^{a}
Means	12.56^{a}	12.78^{a}	
HSD (0.05): Varieties=0.959, Hydro-priming durations=1.446, Varieties* Hydro-priming duration =2.585			

Number of Tillers of Jasmine 85 and Amankwatia Rice Varieties at Twelve Weeks After Sowing as Affected By Hydro-Priming Durations

There were no significant hydro-priming durations and varieties interaction for number of tillers at twelve weeks after sowing (Figure 5). However, for the hydro-priming durations only, seeds hydroprimed for 48 hours produced the highest number of tillers (22.67) and the least (20.50) was produced by the unprimed seeds (Figure 7).

Science World Journal Vol. 19(No 3) 2024 https://dx.doi.org/10.4314/swj.v19i3.22
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

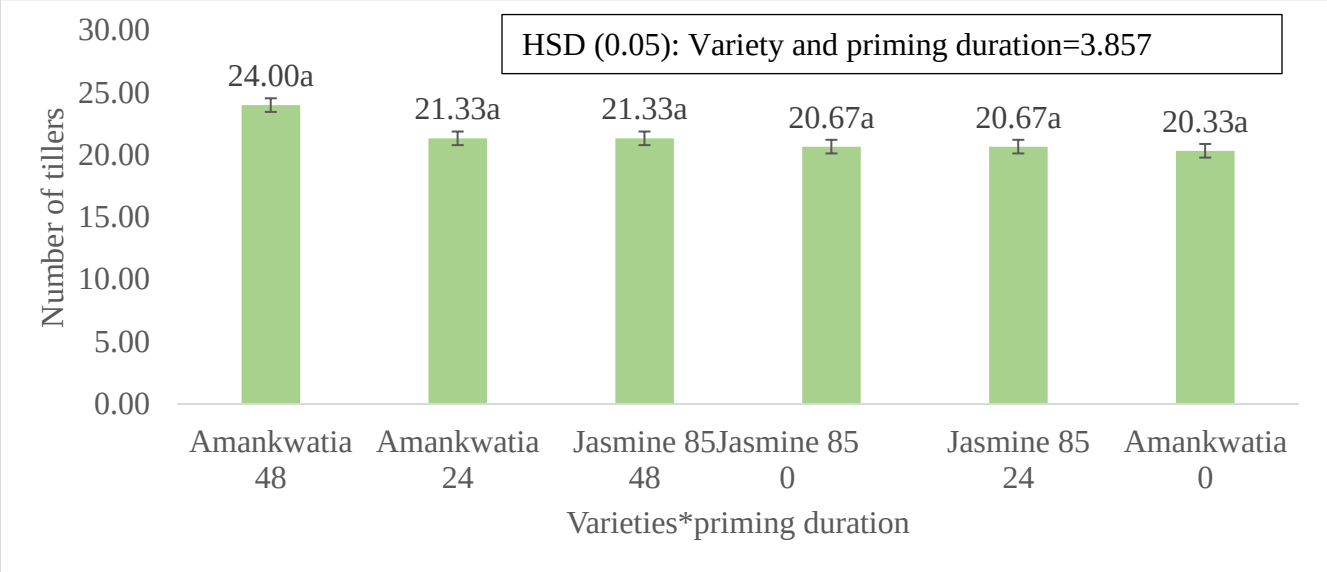

Figure 5: Effect of hydro-priming durations on number of tillers of Jasmine 85 and Amankwatia rice varieties at twelve weeks after sowing

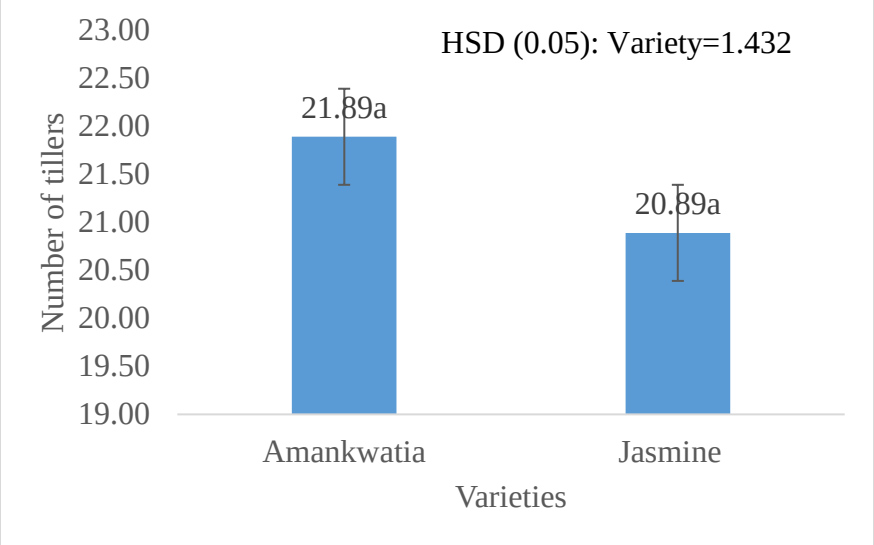

Figure 6: Number of tillers of Jasmine 85 and Amankwatia rice varieties at twelve weeks after sowing

Science World Journal Vol. 19(No 3) 2024 https://dx.doi.org/10.4314/swj.v19i3.22
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

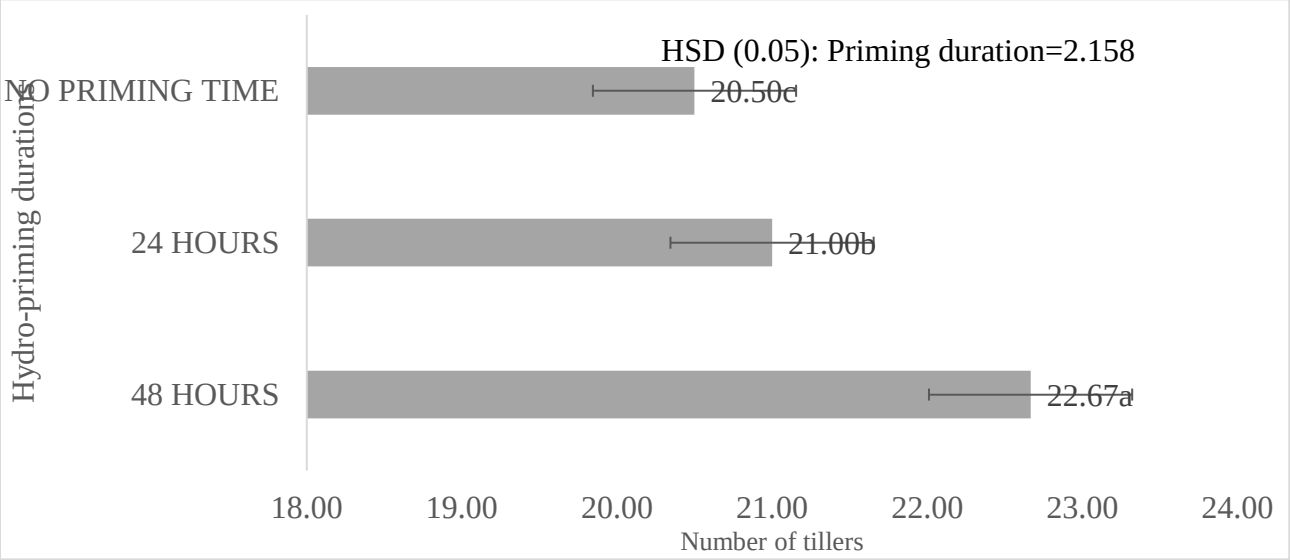

Figure 7: Number of tillers at twelve weeks after sowing as affected hydro-priming durations

Plant Height at Harvest of Jasmine 85 and Amankwatia Rice Varieties as Affected by Hydro-Priming Durations

The interaction between hydro-priming durations and varieties were statistically significant ($p \leq 0.05$) for plant height at harvest (Table 13). Amankwatia rice variety which was hydro-primed for 48 hours produced the tallest plants at harvest (142 cm) and the shortest was produced by Jasmine 85 rice variety which was not hydro-primed (115.33 cm). For the hydro-priming durations only, seeds hydro-primed for 48 hours produced the tallest plants and the shortest was both 24 hours and 0 hours. With respect to the varieties, Amankwatia (124.22 cm) produced tallest plants and Jasmine 85 produced the shortest (119.33 cm).

Table 13: Plant height (cm) at harvest of Jasmine 85 and Amankwatia rice varieties as affected by hydro-priming durations

Varieties			
Hydro-priming Durations	Jasmine 85	Amankwatia	Means
0 hours	115.33^{c}	120.33^{b}	117.83^{b}
24 hours	122.33^{b}	110.33^{d}	116.33^{b}
48 hours	120.33^{b}	142.00^{a}	131.17^{a}
Means	119.33^{b}	124.22^{a}	
HSD (0.05): Varieties=1.237, Hydro-priming durations=1.867, Varieties* Hydro-priming duration =3.337			

Number of Productive Panicles of Jasmine 85 and Amankwatia Rice Varieties as Affected by Hydro-Priming Durations

The interaction between hydro-priming durations and varieties were statistically significant ($p \leq 0.05$) for productive panicles (Table 14). Jasmine 85 rice variety which was hydro-primed for 48 hours produced the highest number of productive panicles (38.00) and the least was produced by Jasmine 85 rice variety which was not hydro-primed (12.33). For the hydro-priming durations only, seeds hydro-primed for 48 hours produced the highest number of productive panicles (29.17) and the least was those not primed (24.33). With respect to the varieties, Jasmine 85 produced highest number of productive panicles (27.56) and Amankwatia produced the least (26.67).

Table 14: Number of productive panicles of Jasmine 85 and Amankwatia rice varieties as affected by hydro-priming durations

Varieties			
Hydro-priming Durations	Jasmine 85	Amankwatia	Means
0 hours	12.33^{f}	36.33^{b}	24.33^{c}
24 hours	32.33^{c}	23.33^{d}	27.83^{b}
48 hours	38.00^{a}	20.33^{e}	29.17^{a}
Means	27.56^{a}	26.67^{b}	
HSD (0.05): Varieties=0.49, Hydro-priming durations=0.7469, Varieties* Hydro-priming duration =1.33			

Science World Journal Vol. 19(No 3) 2024 https://dx.doi.org/10.4314/swj.v19i3.22
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

Number of Unproductive Panicles of Jasmine 85 and Amankwatia Rice Varieties as Affected by Hydro-Priming Durations

The interaction between hydro-priming durations and varieties were statistically significant ($p \leq 0.05$) for unproductive panicles (Table 15). Jasmine 85 rice variety which was not hydro-primed f produced the highest number of unproductive panicles (5.00) and the least was produced by Jasmine 85 rice variety which was hydro-primed for 48 hours (0.67). For the hydro-priming durations only, seeds which were not hydro-primed produced the highest number of productive panicles (3.80) and the least was those hydro-primed for 48 hours (2.17). With respect to the varieties, Jasmine 85 produced highest number of unproductive panicles (3.44) and Amankwatia produced the least (2.67).

Table 15: Number of unproductive panicles of Jasmine 85 and Amankwatia rice varieties as affected by hydro-priming durations

Varieties			
Hydro-priming Durations	Jasmine 85	Amankwatia	Means
0 hours	5.00[a]	2.67[b]	3.80[a]
24 hours	4.67[a]	1.67[d]	3.17[b]
48 hours	0.67[e]	3.67[b]	2.17[c]
Means	3.44[a]	2.67[b]	
HSD (0.05): Varieties=0.248, Hydro-priming durations=0.373, Varieties* Hydro-priming duration =0.193			

Yield of Jasmine 85 and Amankwatia Rice Varieties as Affected by Hydro-Priming Durations

The interaction between hydro-priming durations and varieties were statistically significant ($p \leq 0.05$) for seed yield (Table 16). Jasmine 85 rice variety which was hydro-primed for 48 hours produced the highest seed yield (190 g) which was 2.19 times more than the least yield which was produced by Jasmine 85 rice variety but was not hydro-primed (86.70 g) as well as Amankwatia variety hydro-primed for 24 hours. For the hydro-priming durations only, seeds which were hydro-primed for 48 hours produced the highest seed yield (148.00 g) and the least were those which were not hydro-primed (118.00 g). With respect to the varieties, Jasmine 85 produced highest seed yield (141.00 g) and Amankwatia produced the least (120.00 g).

Table 16: Yield (g) of Jasmine 85 and Amankwatia rice varieties as affected by hydro-priming durations

Varieties			
Hydro-priming Durations	Jasmine 85	Amankwatia	Means
0 hours	86.70[e]	167.67[b]	118.00[c]
24 hours	146.70[c]	86.70[e]	127.00[b]
48 hours	190.00[a]	106.70[d]	148.00[a]
Means	141.00[a]	120.00[b]	
HSD (0.05): Varieties=2.477, Hydro-priming durations=3.743, Varieties* Hydro-priming duration =6.673			

Correlation and Regression Analysis Among Some Parameters

There was strong significant and negative correlation between number of productive panicles and unproductive panicles (Table 17). Additionally, there was a strong significant and positive correlation between seed yield and productive panicles.

Table 17: Correlation and regression analysis among some parameters

Variables	Correlation coefficient	Probability value
Productive and unproductive variables	-0.7378	0.0173
Seed yield and productive panicles	0.9058	0.0000

Regression analysis between number of productive panicles and seed yield

Number of productive panicles significantly affected seed yield such that 82% of variation in the seed yield was attributed to the productive panicles. (Figure 8)

Science World Journal Vol. 19(No 3) 2024 https://dx.doi.org/10.4314/swj.v19i3.22
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

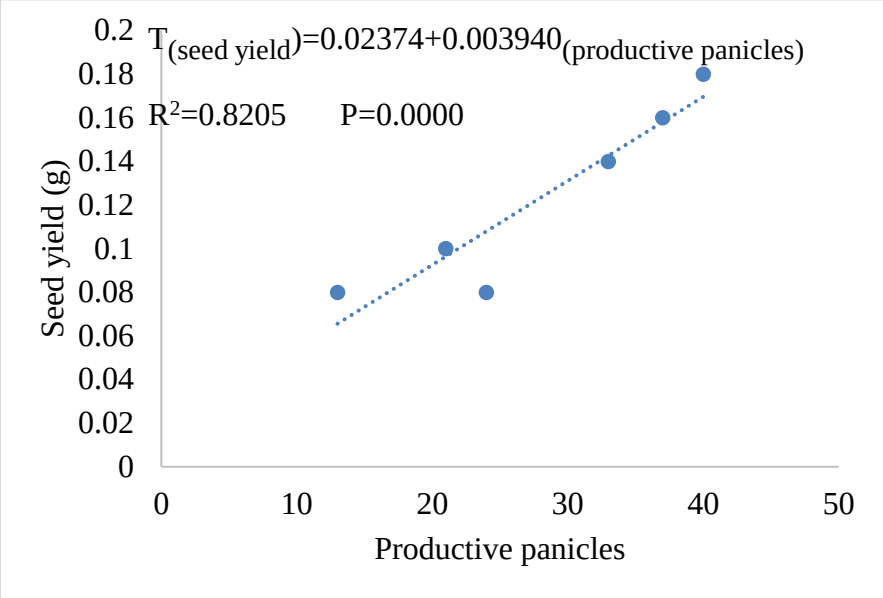

Figure 8: Regression analysis between number of productive panicles and seed yield

DISCUSSION

Our results showed that seeds which were primed for 24 and 48 hours took shorter days to emerge and the unprimed seeds took longer days. This suggests that hydro-priming influenced number of days it took for the seeds to emerge. This could be due to the activation of metabolic activities in the seed leading to the protrusion of the radicle through the seed coat. Seed hydration caused by hydro-priming is sufficient to allow pre-germinative metabolic events but insufficient to permit radicle protrusion through the test (Nejad, 2013). Concerning the priming technique, different solutions with high osmotic potential are used for the soaking of seeds (Ghobadi *et al*, 2012). This technique has become a common seed treatment that can increase rate, percentage and uniformity of germination or seedling emergence, mainly under unfavorable environmental conditions. In the current study, Amankwatia rice variety which was hydro-primed for 24 hours recorded the highest germination percentage and the least was recorded by Jasmine 85 variety which was not hydro-primed. Differences in genetic makeup of the varieties used could account for the variation in germination percentages. These genotypic differences in germination percentage under favorable conditions are likely to have large effect in the time required for seedlings to emerge, which would in turn have significant implication in early vigour and grain yield (Fukai *et al*., 2020). The results of the current study also agree with the findings of Chao *et al*., (2021) who reported of the genotypic differences in eight rice varieties they used for study. Seed priming improves germination performance of seed and strengthens the antioxidant system and thereby increases seed germination potential, leading to an increased stress tolerance in germinating seeds (Kauser *et al.,* 2006, Chen and Arora, 2011). Response of seed to priming is affected by priming duration, osmotic potential of priming solution (Arif *et al.*, 2008), priming agent (Farooq *et al*., 2005) and oxygen supply to seed (Nascimento, 2003). With respect to the varieties, Amankwatia recorded the highest germination percentage and the least was Jasmine 85. Similar trend was observed for vigour index where Amankwatia rice variety which was hyrdoprimed for 24 hours recorded the highest vigour index and the least was recorded by Jasmine 85 variety which was not hydro-primed. It could be explained that the longer hydropriming durations improved emergence, germination and the resultant vigour index. The higher priming duration may have increased α-amylase activity which hydrolyzes more starch and produces more soluble sugar, which helps promote vigorous seedling growth, faster plant growth, higher yields, and better kernel quality. We suspect that the increased α-amylase activity (due to priming) was responsible for the differences we observed in germination, emergence, and seedling growth as reported by Nakao *et al*., (2018). The pre-germinative metabolic processes take place when seeds get into the lag phase of germination and specific amount of water is needed to trigger this process. Seeds which are subjected to short period of hydro-priming would not get enough water that is required for getting seed into the lag phase of germination. However, prolong priming duration will allow excess of water that may exceed the quantity required for the initiation of lag phase of germination and radicle protrusion will occur due to which seed lose its desiccation tolerance thereby results in loss of seed viability (Dekkers *et al*., 2015; Pereira *et al*., 2014). Okamoto and Joly (2000) opined that prolonged submergence may reduce germination percentage due to hypoxia. Our results are in agreement with the findings of Arif *et al.,* (2008) who reported that seed priming durations influence germination percentage positively.

Our results also showed that the no hydro-priming treatment gave tallest plants throughout the growing period of the rice. Moreover, Amankwatia variety also produced the tallest plants as compared to Jasmine 85. This could be due to differences in their genetic makeup as was also reported by Sabri *et al.,* (2020) that the genetic characteristics of the genotype may be the cause of the different growth behavior of rice cultivars. Hydro-priming duration of 48 hours produced the tallest plants at harvest as well as the highest number of leaves and this could be due to the vigourous seedlings which ensured better root development and consequently the increased nutrient usage capacity that allows for a higher relative growth rate in terms of leaves numbers, tillers and panicles

(Mohammed *et al*., 2015) and better plant water status regulation (Ahmed *et al*., 2016). Additionally, Duan *et al*., 2015 reported that the panicle number is a key indicator of rice yield, and our results showed that number of productive panicles significantly affected seed yield such that 82% of variation in the seed yield was attributed to the productive panicles.

Conclusion

The study revealed that seeds which were hydro-primed for 24 and 48 hours took shorter days to emerge. Amankwatia variety which was hydro-primed for 24 hours gave the highest germination percentage and vigour index. Higher tiller numbers at week ten and tallest plants measured at sixth, ninth, tenth and eleventh weeks after sowing were produced by Amakwatia variety which was not hydro-primed. The interaction of variety and hydro-priming durations did not influence plant height at eight weeks after sowing as well as number of tillers. Highest number of leaves at six, eight, nine weeks after sowing as well as number of tillers at weeks ten were produced by Jasmine 85 variety which were hydro-primed at 48 hours. Additionally, highest number of productive panicles and the resultant seed yield were produced by Jasmine 85 variety which were hydro-primed at 48 hours. A correlation analysis showed that there was strong significant and negative correlation between number of productive panicles and unproductive panicles as well as a strong significant and positive correlation between seed yield and productive panicles. Number of productive panicles significantly affected seed yield such that 82% of variation in the seed yield was attributed to the productive panicles. The study concluded that to obtain highest viability, best growth and resultant seed yield Jasmine 85 variety hydro-primed at 48 hours should be highly considered.

Declaration of conflicting interests

The author (s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data availability statement

Original data for this study is with the corresponding author and can be supplied upon request.

REFERENCES

Abdul-Baki, A. A., & Anderson, J. D. (1973). Vigor determination in soybean seed by multiplication. *Crop Science*, *13*(6), 630-633.

Ackaah, F.M., Nyaku, S.T. and Darkwa, E., (2023). Seed-borne fungi associated with diverse rice varieties cultivated in the western north region of Ghana. *International Journal of Microbiology*, *2023*.

Adomako, K.W., Yun, T.H., Appiah-Twum, F., Akolgo, I.G. and Asamoah, E.O., (2020). Factors influencing the production of local rice in Ghana: the moderating role of open innovation. *International Journal of Scientific Research in Science, Engineering and Technology*, *7*, pp.679-695.

Ahmed, M., Qadeer, U., Ahmed, Z.I. and Hassan, F.U., (2016). Improvement of wheat (*Triticum aestivum*) drought tolerance by seed priming with silicon. *Archives of Agronomy and Soil Science*, *62*(3), pp.299-315.

Arif, M., Jan, M.T., Marwat, K.B. and Khan, M.A., (2008). Seed priming improves emergence and yield of soybean. *Pakistan Journal of Botany*, *40*(3), pp.1169-1177.

Asante, M.D., Asante, B.O., Acheampong, G.K., Offei, S.K., Gracen, V., Adu-Dapaah, H. and Danquah, E.Y., (2013). Farmer and consumer preferences for rice in the Ashanti region of Ghana: Implications for rice breeding in West Africa. *Journal of Plant Breeding and Crop Science*, *5*(12), pp.229-238.

Chao, L.I., Brant, E., Budak, H. and Zhang, B., (2021). CRISPR/Cas: a Nobel Prize award- winning precise genome editing technology for gene therapy and crop improvement. *Journal of Zhejiang University. Science. B*, *22*(4), p.253.

Chen, K. and Arora, R., (2013). Priming memory invokes seed stress-tolerance. *Environmental and experimental Botany*, *94*, pp.33-45.

Dekkers, B.J., Costa, M.C.D., Maia, J., Bentsink, L., Ligterink, W. and Hilhorst, H.W., (2015). Acquisition and loss of desiccation tolerance in seeds: from experimental model to biological relevance. *Planta*, *241*, pp.563-577.

Duan, L., Huang, C., Chen, G., Xiong, L., Liu, Q. and Yang, W., (2015). Determination of rice panicle numbers during heading by multi-angle imaging. *The Crop Journal*, *3*(3), pp.211-219.

FAO, *Food and Agriculture Organization of the United Nations*, https://www.fao.org/faostat/en/#data/QCL, 2020.

Farooq, M., Basra, S.M.A. and Hafeez-ur-Rehman, H.U.R., (2007). Seed priming enhances emergence, yield, and quality of direct-seeded rice.

Fikriyah, V.N., (2018). *Detecting rice crop establisment methods using Sentinel-1 multi temporal imagery in Nueva Ecija, Phillipines* (Master's thesis, University of Twente).

Francic, M.M. and Tran, Q., (2018). This report contains assessments of commodity and trade issues made by usda staff and not necessarily statements of official us government policy. *USDA Foreign Agricultural Service, Washington, DC, USA*, p.11.

Fukai, J., Arita, H., Umehara, T., Yoshioka, E., Shofuda, T., Kanematsu, D., Kodama, Y., Mano, M., Kinoshita, M., Okita, Y. and Nonaka, M., (2020). Molecular characteristics and clinical outcomes of elderly patients with IDH-wildtype glioblastomas: comparative study of older and younger cases in Kansai Network cohort. *Brain Tumor Pathology*, *37*, pp.50-59.

Ghobadi M , Shafiei-Abnavi M, Jalali-Honarmand S, Ghobadi M.E, Mohammadi G.H., (2012). Does KNO3 and hydropriming improve wheat (*Triticum aestivum* L.) seeds germination and seedlings growth. *Annals of Biological Research*, 3(7):3156-3160.

International Seed Testing Association (ISTA) Rule (2006). *International rules for seed testing* , Bassersdorf, , Switzerland : International Seed Testing Association

Kaur, H., Chawla, N. and Pathak, M., (2015). Effect of different seed priming treatments and priming duration on biochemical parameters and agronomic characters of okra (*Abelmoschus esculentus* L.). *International Journal of Plant Physiology and Biochemistry*, *7*(1), pp.1-11.

Kauser, R., Athar, H.U.R., Ashraf, N. (2006). Chlorophyll

flurescence: A potential indicator for rapid assessment of water stress tolerance in canola (*Brassica napus* L.). *Pakistan Journal of Botany*, 38: 1501-1509.

Kusano, M., Yang, Z., Okazaki, Y., Nakabayashi, R., Fukushima, A. and Saito, K., (2015). Using metabolomic approaches to explore chemical diversity in rice. *Molecular plant*, *8*(1), pp.58-67.

Mohammed, A.R., Cothren, J.T., Chen, M.H. and Tarpley, L., (2015). 1-Methylcyclopropene (1- MCP)-Induced Alteration in Leaf Photosynthetic Rate, Chlorophyll Fluorescence, Respiration and Membrane Damage in Rice (*Oryza sativa* L.) Under High Night Temperature. *Journal of Agronomy and Crop Science*, *201*(2), pp.105-116.

Nakao, Y., Asea, G., Yoshino, M., Kojima, N., Hanada, H., Miyamoto, K., Yabuta, S., Kamioka, R. and Sakagami, J.I., (2018). Development of hydropriming techniques for sowing seeds of upland rice in Uganda. *American Journal of Plant Sciences*, *9*(11), pp.2170-2182.

Nascimento, W.M., (2003). Muskmelon seed germination and seedling development in response to seed priming. *Scientia Agricola*, *60*, pp.71-75.

Nejad, H.A., (2013). The effects of seed priming techniques in improving germination and early seedling growth of Aeluropus macrostachys. *International Journal of Advanced Biological and Biomedical Research*, *1*(2), pp.86-89.

Okamoto, J. and Joly, C.A., (2000). Ecophysiology and respiratory metabolism during the germination of *Inga sessilis* (Vell.) Mart.(Mimosaceae) seeds subjected to hypoxia and anoxia. *Brazilian Journal of Botany*, *23*, pp.51-57.

Pereira, R.G., Veloso, C.M., da Silva, N.M., de Sousa, L.F., Bonomo, R.C.F., de Souza, A.O., da Guarda Souza, M.O. and Fontan, R.D.C.I., (2014). Preparation of activated carbons from cocoa shells and siriguela seeds using H3PO4 and ZnCL2 as activating agents for BSA and α-lactalbumin adsorption. *Fuel Processing Technology*, *126*, pp.476-486.

Ragasa, C. and Chapoto, A., (2017). Limits to Green Revolution in rice in Africa: The case of Ghana. *Land Use Policy*, *66*, pp.304-321.

Sabri, R.S., Rafi, M.Y., Ismail, M.R., Yusuff, O., Chukwu, S.C. and Hasan, N.A., (2020). Assessment of agro-morphologic performance, genetic parameters and clustering pattern of newly developed blast resistant rice lines tested in four environments. *Agronomy*, *10*(8), p.1098.

Seshu, D.V. and Dadlani, M., (1991). Mechanism of seed dormancy in rice. *Seed Science Research*, *1*(3), pp.187-194.

Zulfiqar, F., (021). Effect of seed priming on horticultural crops. *Scientia horticulturae*, *286*, p.110197.