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COMPARATIVE STUDY OF SPEED BREEDING EFFICIENCY IN PEANUT CULTIVARS UNDER DIFFERENT SOIL MIXTURES

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ABSTRACT
Climate change threatens crop sustainability. Rapid Generation Advance, like speed breeding, can reduce growth time and improve peanut production in Pakistan. However, legal implications remain. The study investigated the effectiveness of speed breeding in advancing three peanut cultivars under different potting media ratios. The study recorded three generations of each cultivar, subjected them to dormancy breakage, and analyzed their morphological characteristics. The experiment revealed significant differences in morphological parameters among genotypes and treatments, with BARI-2011 showing the highest number of branches, earliest flowering, and peg emergence. The ratio of sand, silt, and manure (60:30:10) provided the most acceptable results in peg emergence and flower initiation. It has been observed from the results that the interaction between the ratio of sand, silt and manure (30:60:10) and BARI-2011 was more dominant in having more primary and secondary branches, days to germination, plant height, and early flower initiation, and peg emergence in almost every generation. However, the current study is not particularly based on genetic variations of the varieties but entirely on environmental variations. Therefore, it is concluded that this genotype can be used by plant breeders to get 3 to 4 generations of peanuts in one year under the facilities of speed breeding.

Keywords: *Speed Breeding, Peanut, Rapid Generational Advancement, Environmental Variation, Soil Medium*

INTRODUCTION
Arachis hypogaea (Peanut) is an important oilseed, legume, and fodder crop that is being grown over an area of 28.5 million hectares with a production of 46 million tonnes (FAO) and a productivity of 1611 kg/ha. It has become an important crop far from its originating region, like many other crops (Bertioli *et al.,* 2011). Because of its high oil content (46–58 %) and protein content (22–32 %), it is known to be an important crop that can contribute to issues of food security. Also, it has high levels of heart-healthy oleic acid, folic acid, linoleic acid, fibre, and easy-to-digest proteins (Favero *et al*., 2006).

Due to the changing climate, crop production has been facing significant losses recently (Mall *et al*., 2017). Thus, providing an adequate amount of food for the whole world has become a major challenge for all sectors of agriculture. In order to ensure global food security, genetic gains must be enhanced beyond current achievements (Lin *et al*., 2016). Therefore, more novel methods or techniques are needed to increase breeding programs. However, conventional breeding methods have played an important role in providing improved varieties globally. As these traditional methodologies are time-consuming and limited to only one to two generations, an improved breeding method is needed that can help improve an improved variety in a short period. Plant breeders want to speed up breeding generations and shorten the time needed to generate commercial cultivars (Sysoeva *et al*., 2011).

Speed breeding is considered an important tool for rapid generation advancement in the number of crops that can accelerate the plant developmental rate with the help of prolonged photoperiods (Sysoeva *et al*., 2011). Traditional techniques take 10-15 years to develop a variety having desirable characteristics; however, speed breeding allows up to 6 generations of growth for wheat, barley, and chickpea, and four generations for canola per year (Acquaah, 2012). It is a low-cost program that uses small spaces for growing plants, and the inbred lines can also develop. It requires the growing of plants in controlled environmental conditions (CEnvC), 24-hour high-intensity photosynthetic active radiation (PAR) lamps, and optimum temperature ranges (28 to 32 centigrade) in the greenhouse. Speed breeding tends to double the genetic gain in crops more than conventional breeding methods (Jighly *et al*., 2019). Under rapid breeding conditions, high throughput phenotyping opens up new avenues for discovering and incorporating new beneficial traits while conserving resources (Al-Tamimi *et al*., 2016). Targeting delegate attributes such as seminal root number, for example, facilitated rapid selection for enhanced root architecture in mature plants under speed breeding conditions (Richard *et al*., 2015).

Furthermore, limited research work has been published on speed breeding in peanuts and other crops like wheat, barley, chickpea, pea, Medicago, and canola. Global warming and environmental changes make the weather unpredictable and alter the rainfall pattern. So, under normal conditions, the peanut cultivars were still limited to 1-2 generations per year. That's why there is a need to develop a variety of improved traits in a shorter period of time that can cope with increasing climate change. The objective of the study is to evaluate the potential of different peanut genotypes for rapid generational advancement.

METHODS AND MATERIALS

Breaking Seed Dormancy:

The experiment was initiated in May 2021 after the harvesting of fresh pods at Arid Agriculture University, Rawalpindi. The experimental design used in this experiment was Complete Randomized Design (CRD) with two factorials. Three varieties of peanuts were grown in pots, and their pods were immediately sun-dried for seven days after harvesting. To break the dormancy, the peanuts were subjected to four different treatments: 100 ppm ethrel for 6 hours (T1), 200 ppm ethrel for 6 hours (T2), 300 ppm ethrel for 6 hours (T3), and 400 ppm ethrel for 6 hours (T4). Before applying any treatment, the seeds are required to be washed with distilled water and imbibed in distilled water overnight. The next day, seeds were washed again with distilled water and treated with ethrel of different concentrations for 6 hours. After six hours, seeds were washed with water and dried with tissue paper, which was then sown in growing trays of peat moss potting media in order to record the germination time of the seed under different treatments.

Plant Materials:

Three locally cultivated varieties, i.e., Fakhr e Chakwal (V1), BARI-2016 (V2), and BARI-2011 (V3), were obtained from Barani Agricultural Research Institute (BARI), Chakwal. The research was conducted in a glasshouse under 22 hours of lights supplemented by LEDs placed 90 cm above the pots and 2 hours of dark periods with temperatures ranging from 28^{o}C to 32^{o}C. The glass chamber in which the experiment was

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conducted was constructed with a length of 4 feet, a width of 2.5 feet, and a height of 2.5 feet. Two LEDs with 60 % red (660 nm) and 40 % blue (460 nm) diodes and the two LED bulbs are installed in the chamber. In the winter, heaters were used to maintain the temperature, while in the summer, portable fans.

Three treatments of different potting composition mixtures, in which three seeds from each variety were planted a few cm deep, were replicated three times for each variety. The treatments were on the different ratios of sand: silt: manure, *viz.,* 45:45:10 (T1), 60:30:10 (T2), and 30:60:10 (T3). The performance was analyzed in each potting medium and was determined for early maturity with specific potting media. 36 pots were sown with peanut varieties inside the glass chamber and the remaining nine outside the chamber.

Fig. 1 Glass chamber construction, potting mixture preparation and number of pots

Morphological Parameters:

The morphological attributes were recorded at different stages of crops, which determines changes among the different genotypes of peanuts under different treatments. These traits include days to germination, plant height, number of primary and secondary branches per plant, days to flower initiation, peg emergence, and fresh and dry weight with pods.

Number of Generations

Three generations of peanuts were sown and harvested. The first generation was sown on May 1, 2021, and harvested on August 15, 2021, followed by the second generation, which was sown on September 1, 2021, and harvested on December 10, 2021, and then the third generation, which was sown on January 29, 2022, and harvested on May 10, 2022.

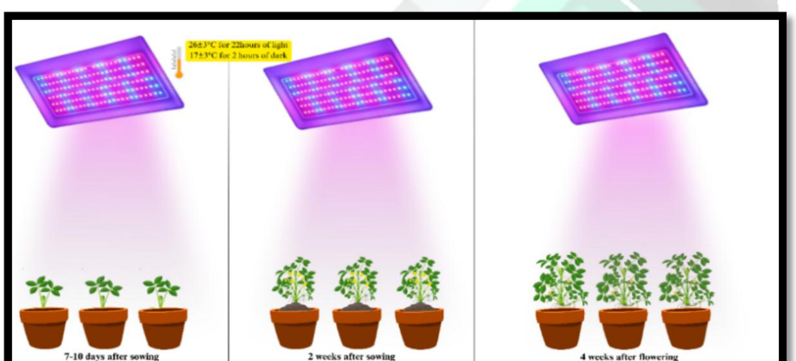

Fig 2 Speed breeding plants under LED light: 7-10 days, 2 weeks, and 4 weeks after flowering.

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Statistical Analysis

The data recorded for the different parameters were subjected to the analysis of variance (ANOVA) to determine the significant difference between treatments. If there is any significant difference, then the LSD (Least Significant Difference) of the mean will also be calculated at a 5 % level of probability using the Statistix 8.1 software package.

RESULTS AND DISCUSSION

Breaking Seed Dormancy

The dormancy of the seed was not affected by T1 (100 ppm of ethrel for six hours), T3 (300 ppm of ethrel for six hours), or T4 (400 ppm of ethrel for six hours), but T2 (200 ppm of ethrel for six hours) showed a significant effect in breaking seed dormancy, which resulted in increased germination time. Our studies were by Joshi, Phartyal, and Arunkumar (2017), who reported that pre-soaked seeds in water helped in early germination as compared to non-treated seeds. Ketring and Morgan (1969) reported that ethephon helped increase the germination of dormant seeds by soaking the seeds in water and then treating them. The seeds showed 100 percent germination. Another study reported by De Pauw and Clarke (1976) on wheat shortened the generation time by 12-23 days and increased germination response by extending the duration of H_2O_2 treatment at a low temperature of 11 °C.

First Generation Data (1st May to 15th August)

The first generation of peanut varieties was sown on 1st May 2021 after breaking its dormancy and the period continued till 15 August 2021. The analysis of the variance table for first-generation data is shown in Table 1.

Table 1: Analysis of variance for different characters in the first generation

Source	DG	FI	PB	SB	PE	PH	FW	DW
Treatment	2.02778*	15.361**	4.1111**	0.1944	2.6944**	45.8611 **	62.111**	27.4444**
Variety	6.36111**	166.778**	18.8611**	17.8611**	33.4444**	4.3611**	91.194**	55.0278**
Treatment *Variety	6.81944**	50.111**	17.278**	5.5278**	7.3194**	1.7361*	111.986**	58.2361**
Error	0.52778	1.167	0.6019	0.5643	0.3704	0.6019	1.444	2.3333
CV	10.18	3.16	8.29	10.6	1.61	3.73	6.29	20.52

O'Connor *et al.* (2013) reported that speed breeding applications in peanuts had given successful results. Hickey et al., (2009) described the use of CEnvC and continuous photosynthetic radiation in a wheat breeding program that was successfully transferred in a peanut breeding system. The system described in this study was able to develop a generation in about 95 to 100 days in peanut which was considered to be a significant improvement from traditional methods of breeding which requires 140 to 150 days to develop a generation in peanut breeding system. For days to germination, it has been observed that the mean values and least significant difference for early germination were seen in the BARI-2011 at a ratio of sand, silt, and manure (30:60:10) (5.5000), followed by Fakhr e Chakwal under the ratio of sand, silt, and manure (30:60:10) (6.0000), and for late germination, they were shown in Fakhr e Chakwal under the ratio of sand, silt, and manure (60:30:10) (8.7500), followed by Fakhr e Chakwal under ratio of sand, silt and manure (45:45:10) (8.5000). These results showed that is a valuable source for decreasing the time of germination and maturing early in a speed breeding facility as shown in Fig 3.

A fundamental tenet of speed breeding involves controlling temperature, light intensity, and day length to encourage early flowering in plants by increasing photosynthetic rates, combined with annual seed harvesting (Chiurugwi *et al.,* 2019; Watson *et al*., 2018). Flower initiation involves the development of all the important characteristics to produce an inflorescence by the

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meristem (Kinet, 1993). Considering the days to flower initiation, it was analyzed that BARI-2016 under the ratio of sand, silt, and manure (30:60:10) showed the highest mean value (39.750), followed by BARI-2016 under the ratio of sand, silt, and manure (60:30:10) (38.500), and BARI-2011 under the ratio of sand, silt and manure (30:60:10) showed the lowest mean value (28.000), followed by BARI-2011 under the ratio of sand, silt and manure (30:60:10) (29). These results indicate that BARI-2011 under the ratio of sand, silt, and manure (30:60:10) showed the best results in lessening the flower initiation time as shown in Fig 3. Our results followed many researchers who stated that genotype has a great influence on the days of flower initiation (Cahaner & Ashri, 1974; Parmar, Malik, Grewal, Bhatia, & Singh, 1989).

As for the evaluated data for the number of primary branches per plant, it had been observed that the highest mean was shown by BARI-2016 under the ratio of sand, silt, and manure 60:30:10 (12.000) followed by Fakhr e Chakwal under the ratio of sand, silt and manure was (60:30:10) (11.75), and the lowest mean was shown by BARI-2011 under the ratio of sand, silt, and manure (60:30:10) (7) followed by BARI-2016 under the ratio of sand, silt, and manure (60:30:10) (7.5), which means that BARI-2011 under the ratio of sand, silt, and manure (60:30:10) has the maximum number of primary branches per plant as shown in Fig 3.

For the number of secondary branches per plant, it had been observed that Fakhr e Chakwal under the ratio of sand, silt, and manure (60:30:10) (9) and showed the highest mean value, followed by BARI-2016 under the ratio of sand, silt, and manure (60:30:10) (8), and BARI-2011 under the ratio of sand, silt, and manure (60:30:10) (5.5) showed the lowest mean value, followed by BARI-2016 under the ratio of sand, silt and manure (30:60:10) (5.5), which means that BARI-2011 under the ratio of sand, silt and manure (60:30:10) has the maximum number of secondary branches per plant as shown in Fig 3.

The data for peg emergence revealed that Fakhr e Chakwal under the ratio of sand, silt, and manure (60:30:10) showed the highest mean value of 65.75, followed by Fakhr e Chakwal under the ratio of sand, silt, and manure (30:60:10) with a mean value of 65.75, and BARI-2016 under the ratio of sand, silt, and manure (30:60:10) and the ratio of sand, silt and manure (60:30:10) showed the lowest mean values of 61 and 61.25, respectively, which means BARI-2011 showed early peg emergence under the ratio of sand, silt and manure (30:60:10) as shown in Fig 3.

Plant height is an important morphological trait that contributes to yield. The interaction between BARI-2011 under the ratio of sand, silt, and manure (30:60:10) with a mean value of 23.5 showing maximum plant height, followed by BARI-2016 under the ratio of sand, silt and manure (30:60:10) with a mean value of 22.75, and BARI-206 under the ratio of sand, silt, and manure was (45:45:10) with a mean value of 18 showed minimum plant height, followed by Fakhr e Chakwal under the ratio of sand, silt and manure was (45:45:10) with a mean value of 18.75 as shown in Fig 3. Our studies for plant height were consistent with Jähne *et al.,* 2020, who reported that speed breeding increased soybean, rice, and amaranth heights without creating unstable plant stands in other crops.

The interaction between treatment and variety revealed that BARI-2011 under the ratio of sand, silt, and manure (30:60:10) had a maximum mean value of 29.75, which means it has maximum fresh weight with pods, followed by BARI-2011 under the ratio of sand, silt and manure (60:30:10) with a 22 mean value, and Fakhr e Chakwal under the ratio of sand, silt and manure (30:60:10) had a minimum mean value of 13.75, which means minimum fresh weight with pods, followed by BARI-2011 under the ratio of sand, silt, and manure (45:45:10) with a mean of 15 as shown in Fig 3.

The results showed that BARI-2011 under the ratio of sand, silt, and manure (30:60:10) had a maximum mean value of 16 for dry weight with pods, followed by BARI-2016 under the ratio of sand, silt, and manure (60:30:10) (9.25), and BARI-2016 under the ratio of sand, silt, and manure (60:30:10) and Fakhr e Chakwal under the ratio of sand, silt and manure was (30:60:10) showed minimum mean values of 4.5 for dry weight with pods as shown in Fig 3. Hickey *et. al.,* (2017) reported that modified backcrossing methodology and speed breeding required two

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years to develop resistant barley lines otherwise they are susceptible to different diseases.
However, considerable challenges were approached in maintaining the controlled environmental conditions in the speed breeding glass chamber. Groundnut requires about 25 °C to 30 °C temperature to grow but the temperature rises to 40 °C or even more in summers. To maintain the CEnvC summer portable fans were utilized inside the speed breeding glass chamber.

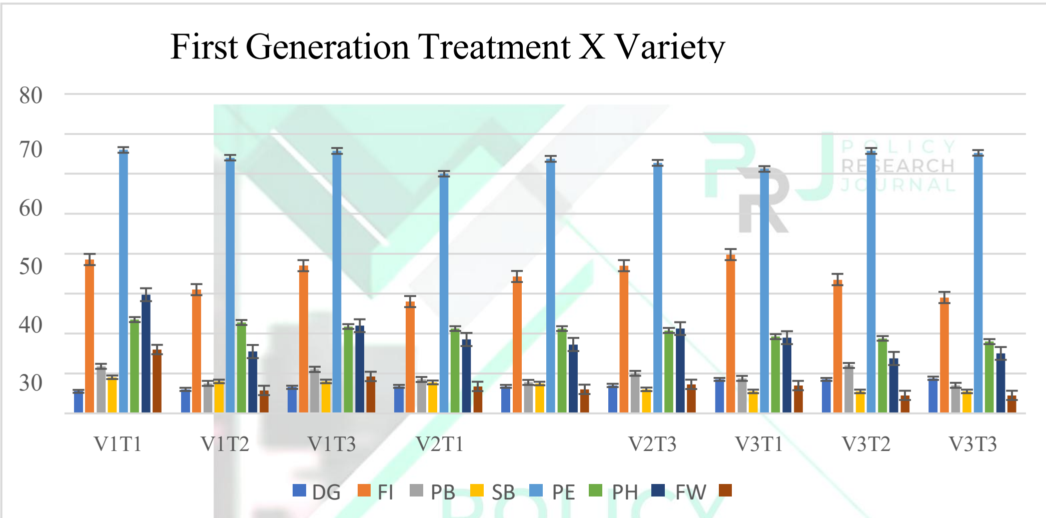

Fig. 3 Graphical representation of treatment x variety means for days to germination (DG), days to flower initiation (FI), number of primary branches per plant (PB), number of secondary branches per plant (SB), peg emergence (PE), plant height (PH), fresh weight with pods (FW), and dry weight with pods (DW).

Second Generation Data (1st September to 10th December)

The second generation of peanut varieties was sown on 1st September 2021 after breaking its dormancy and the period continued till 10 December 2021. The analysis of the variance table for second-generation data is given below.

Table 2: Analysis of variance for different characters in second generation

Source	DG	FI	PB	SB	PE	PH	FW	DW
Treatment	4.0833**	23.0833**	1.36111	0.36111	35.5833**	1.0278	2.861	3.6944*
Variety	19**	27.25**	5.77778**	4.19444**	31.5833**	20.5278**	33.361**	9.3611**
Treatment* Variety	1.2083**	9.9583**	7.23611**	1.81944*	12.7917**	3.1111*	107.361**	13.5278**
Error	0.2593	0.8981	0.74074	0.49074	1.7593	1.3611	2.065	0.8148
CV	6.11	2.88	9.28	11.31	2.08	5.65	8.36	3.5

For the days to germination, it has been observed that the mean values and least significant difference for early germination were seen in the BARI-2011 at the ratio of sand, silt and manure

(30:60:10) (6.25) whereas BARI-2016 at the ratio of sand, silt and manure (60:30:10) showed the maximum mean value which that BARI-2016 under the ratio of sand, silt and manure (60:30:10) showed early germination as shown in Fig. 4.

It is revealed from the results that interaction BARI-2011 under the ratio of sand, silt and manure (30:60:10) shows the minimum mean value of 30 days whereas Fakhr e Chakwal under the ratio of sand, silt and manure (45:45:10) and BARI-2016 under the ratio of sand, silt and manure (60:30:10) showed the maximum mean value of 35.5 and 34.75 respectively for days to flower initiation. The average mean for the days to flower initiation were in compliance with the work of (Rao, 1988). The data observed for the number of primary branches per plant reveals that the interaction BARI-2011 under the ratio of sand, silt and manure (30:60:10) has the maximum number of primary branches per plant with a mean value of 11 and BARI-2016 under the ratio of sand, silt and manure (30:60:10) has the minimum number of primary branches per plant with a mean value of 7.25 as shown in Fig 4. The results showed that BARI-2011 under the ratio of sand, silt and manure (30:60:10) has a maximum number of secondary branches per plant with a mean value of 7.5 followed by BARI-2016 under the ratio of sand, silt and manure (45:45:10) with a mean value of 6.5 whereas Fakhr e Chakwal under the ratio of sand, silt and manure (30:60:10) showed a minimum number of secondary branches per plant with a mean value of 5.4 followed by BARI 2016 under the ratio of sand, silt and manure (30:60:10) with the mean value of 5.25 as shown in Fig 4.

However, considerable challenges were approached in maintaining the controlled environmental conditions in the speed breeding glass chamber. Groundnut requires about 25 °C to 30 °C temperature to grow but the temperature falls to 16 °C to 22 °C during winter. To maintain the temperature, a gas heater is used.

The analyses for the peg emergence showed that the interaction Fakhr e Chakwal under the ratio of sand, silt and manure (30:60:10) took the least time for the peg emergence with a mean value of 60.25 whereas Fakhr e Chakwal under the ratio of sand, silt and manure (45:45:10) showed the maximum time for peg emergence with a mean value of 67.25. The plant height significantly contributes to the ultimate yield. The BARI-2011 under the ratio of sand, silt and manure (30:60:10) showed maximum height with a mean value of 22.75 followed by BARI-2011 under the ratio of sand, silt manure (60:30:10) (21.75) and BARI-2016 under the ratio of sand, silt and manure (45:45:10) showed minimum height with a mean value of 19 followed by BARI-2016 under the ratio of sand, silt and manure (30:60:10) (18.75) as shown in Fig. 4.

The results evaluated for the fresh weight with pods showed that Fakhr e Chakwal under the ratio of sand, silt and manure (45:45:10) and BARI-2011 under the ratio of sand, silt and manure (30:60:10) have a maximum mean value of 22.57 and Fakhr e Chakwal under the ratio of sand, silt and manure (30:60:10) showed the least mean value of 12.25. For the morphological attribute dry weight with the pods, the results showed that the BARI-2011 under the ratio of sand, silt and manure (30:60:10) and Fakhr e Chakwal under the ratio of sand, silt and manure (60:30:10) have maximum dry weight with pods with a mean value of 9.25 and 8.5 respectively whereas Fakr e Chakwal under the ratio of sand, silt and manure (30:60:10) and BARI-2016 under the ratio of sand, silt and manure (45:45:10) showed minimum weight with a mean value of 4.5, and 5 respectively as shown in Fig 4.

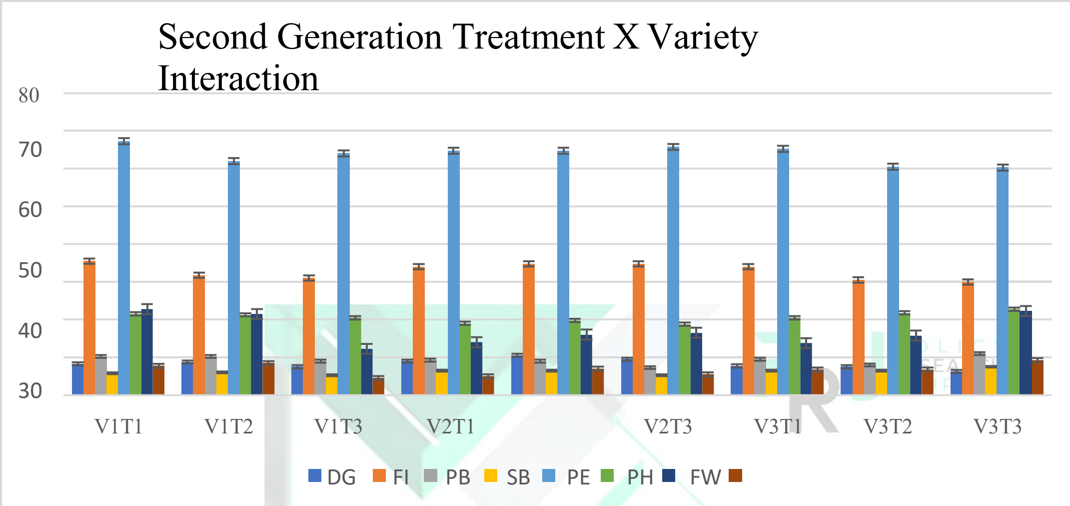

Fig. 4 Graphical representation of treatment x variety means for days to germination (DG), days to flower initiation (FI), number of primary branches per plant (PB), and number of secondary branches per plant (SG), peg emergence (PE), plant height (PH), fresh weight with pods (FW), and dry weight with pods (DW).

Third Generation Data (January 29th to May 10th)

The third generation of peanut varieties was sown on 29 January 2021 after breaking its dormancy in 15 days and the period continued till 10 May 2021. Table 3 shows an analysis of variance for the third generation.

Table 3: Analysis of variance for different characters in third-generation

Source	DG	FI	PB	SB	PE	PH	FW	DW
Treatment	0.3611	2.8611**	3.25**	4.1111**	2.5278*	5.77778**	186.028**	67.861**
Variety	14.7778**	40.7778**	20.5833**	12.1111**	33.4444**	8.69444**	6.028	4.528
Treatment*Variety	1.1111*	5.7778**	1.3333*	1.1111**	4.6528**	2.94444**	304.444**	109.403**
Error	0.3889	0.4167	0.4352	0.2593	0.5833	0.61111	2.556	2.343
CV	8.57	1.97	6.44	7.22	1.19	3.44	7.42	17.6

The least significant difference test for variety x treatment interaction showed that under the influence of sand, silt and manure (30:60:10), BARI-2011 (5.5) performed excellently, which means that BARI-2011 germinates earlier under the ratio of sand, silt and manure (30:60:10), while BARI-2016 under the ratio of sand, silt and manure (60:30:10) (8.5) was the least performing and took the maximum time for germination, followed by Fakhr e Chakwal under the ratio of sand, silt and manure (30:60:10) (8.25) as shown in Fig 5.

The least significant difference test for variety x treatment showed that the interaction BARI-2011 under the ratio of sand, silt and manure (30:60:10) performed earlier than others with a mean value of 29.5, while Fakhr e Chakwal under the ratio of sand, silt and manure (30:60:10) showed a maximum mean value of 35 as shown in Fig 5.

The results for the number of primary branches per plant showed that the interaction BARI-2011 under the ratio of sand, silt and manure (30:60:10) has a maximum number of primary branches with a mean value of 12.5 and BARI-2016 under the ratio of sand, silt and manure (30:60:10) has the least number of primary branches with a mean value of 8.75 as shown in Fig 5.

The analyses for the secondary branches per plant showed that the influence under the ratio of sand, silt and manure (60:30:10) BARI-2011 has a maximum mean value of 8.5; on the other hand, the interaction BARI-2016 under the ratio of sand, silt and manure (45:45:10) has a minimum mean value of 5.25, followed by BARI-2016 under the ratio of sand, silt and manure (60:30:10) (6) as shown in Fig 5.

The results for the morphological attribute peg emergence indicated that the BARI-2011 under the influence of sand, silt and manure (30:60:10) took the least time for peg emergence with a mean value of 61.5, followed by BARI-2011 under the ratio of sand, silt and manure (60:30:10) (61.75), while the interaction of Fakhr e Chakwal under the ratio of sand, silt and manure (30:60:10) took the maximum time for peg emergence with a mean value of 66.25, followed by BARI-2016 under the ratio of sand, silt and manure (45:45:10) (65.75) as shown in Fig 5.

The statistical analysis for the plant height showed that Fakhr e Chakwal under the ratio of sand, silt and manure (45:45:10) has a maximum height of 23.75 mean value, followed by BARI-2011 under the ratio of sand, silt and manure (30:60:10) (23.75), while BARI-2016 under the ratio of sand, silt and manure (45:45:10) shows a minimum plant height of 20.75 mean value, followed by BARI-2016 under the ratio of sand, silt and manure (60:30:10) (21.25) as shown in Fig 5.

The results showed that BARI-2016 under the action of sand, silt and manure (60:30:10) has the maximum fresh weight with the pods with a mean value of 32.35, followed by BARI-2011 under the ratio of sand, silt and manure (30:60:10) (30). In contrast, Fakhr e Chakwal under the ratio of sand, silt and manure (30:60:10) was observed to have the least fresh weight with the pods with a mean value of 13.75, followed by BARI-2011 under the ratio of sand, silt and manure (45:45:10) (5) as shown in Fig 5.

The observation for the dry weight with pods showed that BARI-2011 under the ratio of sand, silt and manure (30:60:10) has the maximum dry weight with a mean value of 16, followed by Fakhr e Chakwal under the ratio of sand, silt and manure (60:30:10) with a mean value of 13.75, while BARI-2011 under the ratio of sand, silt and manure (45:45:10) and Fakhr e Chakwal under the ratio of sand, silt and manure (30:60:10) showed the minimum dry weight with pods with a mean value of 4.5 for both as shown in Fig 5. Rowell *et al*., (1999) reported that plants exposed to continuous light produced 42% more foliage biomass, 34% less pod yield, 66% less mature seed yield, and 94% lower harvest index which means temperature significantly influenced immature seed yield and harvest index.

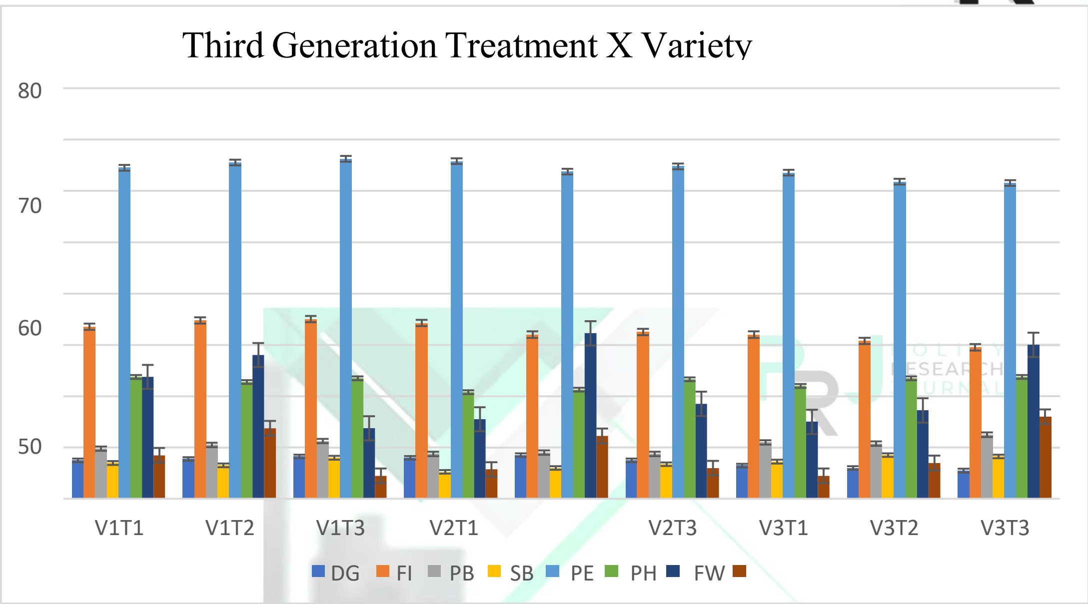

Fig. 5 Graphical representation of treatment x variety means for days to germination (DG), days to flower initiation (FI), number of primary branches per plant (PB), number of secondary branches per plant (SB), peg emergence (PE), plant height (PH), fresh weight (FW) and dry weight with pods (DW).

Overall Comparison of Peanut Genotypes Grown in Field and Speed Breeding Chamber

Under field conditions days to germination took about 6 to 10 days after sowing, while on the other hand under speed breeding chamber days to germination took 5 to 9 days after sowing. Days to flower initiation took 28 to 35 days after sowing under field conditions, while it took 29 to 34 days after sowing under a speed breeding chamber. The plant height is estimated to be 45 to 55 cm under field conditions while under speed breeding chamber it is estimated to be 18 to 21 cm. The harvesting time ranges from 140 to 150 days after sowing under field conditions while it ranges from 95 to 100 days after sowing under a speed breeding chamber. For the high-quality Japanese soybean cultivar Enrej, Nagatoshi and Fujita (2019) created a standardized fast-generation advancement methodology that shortened the crop's duration from 102–132 days to 70 days.

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Fig. 6 Pictures from different stages of groundnut A) germination B) flowering C) pegging D) pod formation

CONCLUSION

The study aimed to explore the potential of speed breeding for rapid generation advancement of three peanut cultivars (Fakhr-e-Chakwal, BARI-2016, and BARI-2011) under different potting media ratios. The seeds were subjected to dormancy breakage before sowing and morphological characteristics were recorded for statistical analysis. The results showed significant differences among genotypes and treatments for morphological parameters, with BARI-2011 showing the highest number of primary and secondary branches, earliest flowering, and peg emergence. Fakhr e Chakwal and BARI-2016 did not yield significant results. The most acceptable treatment for peg emergence and flower initiation was T3 (60:30:10). The interaction between treatment 3 and BARI-2011 was more dominant in terms of primary and secondary branches, days to germination, plant height, early flower initiation, and peg emergence in almost every generation. The study emphasized the environmental interaction, not genetic variations, and concluded that BARI-2011 was an outstanding genotype in treatment 3 and exceptional performance among other treatments. This genotype can be used by plant breeders to achieve 3 to 4 generations of peanuts in one year under speed breeding facilities.

Authors' contribution

M. Zahid and M. U. Hassan conceived and designed the study. M. Zahid executed the experiment. M. H. Asadi wrote the manuscript. G. Shabbir and M. S. Ahmed analyzed the data. All authors interpreted the data, critically revised the manuscript for important intellectual contents, and approved the final version.

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