The recent study’s objective was to detect variability in Egyptian multi-cut barseem genotypes via studying ten different commercial varieties regarding forage yield production during two successive winter seasons (2018/19 and 2019/20). These varieties, namely; Hartuor, Narmar, Sinai 2, Giza 6, Helaly, Gemiza, Serw1, Sakha 4, Khadrawy and Meskawi. Four cuttings were taken in each season. The analysis of variance in each season revealed that the mean squares due to barseem genotypes were significant for all studied traits. A wide range of variation was observed for plant height traits. Barseem varieties had fresh seasonal yield ranging from 114.70 to 137.72 and averaging 125.20 ton acre-1 in the first season. In the second season, the genotypes had a mean seasonal new yield of 146.89 with a range of 120.26 to 162.07 ton acre-1. Seasonal forage dry yield of the varieties ranged from 20.72 to 26.53 with a grand mean of 24.31 ton acre-1 in the first season, and it went from 25.10 to 29.84 with a great standard of 28.65 ton acre-1 in the 2nd season. Based on per se performance, the variety Khadrawy was identified for total fresh and dry forage yields. The values of PCV for different characters were higher than corresponding GCV values. Estimates of heritability were high for plant height at 2nd cut in the two seasons, plant height at the 1st and 2nd cuts, and seasonal dry yield in the second season. High heritability values coupled with high genetic advance were recorded for plant height at 2nd and 3rd cut in the two seasons, at 4th cut in the first season, and 1st cut in the second season. Genetic advance as percent of the mean (GAM) was found to be the highest for plant height at 1st cut in the second season (21.78 %) followed by seasonal dry yield in 2nd season (16.07 %).

Genotypes were evaluated under two locations. They reported that the phenotypic coefficient of variation (P.C.V) was low in all fresh forage yield cuts. The broader range of variation was with plant height and dry matter traits. Thirty-two accessions of multi-cut Egyptian clover were evaluated under regular irrigation and drought conditions for forage yield by Bakheit and El-Hinnawy (1993). They found that a considerable variation among the bio-agronomic traits was higher when the cut was applied at early flowering. Heritability and genetic advance are important selection parameters. Heritability estimate of a character is essential for plant breeders because it provides information on the extent to which a particular name can be transmitted from the parent to the progeny (Allard, 1960; and Poehlman and Sleper, 1995). Similarly, the genetic advance is also considered necessary because genetic advance shows the degree of the gain obtained in character from one selection cycle. Heritability estimates and expected genetic gain are more useful than the heritability value alone in predicting the Egyptian clover to estimate the progress of their breeding program in the future. Martinelli et al., (1992) evaluated the phenotypic variability and adaptability for bio-agronomic traits in thirty-two barseem genotypes (Trifolium alexandrinum L) under field conditions. They found that the range of variation among the bio-agronomic traits was higher when the cut was applied at early flowering.
the resultant effect for selecting the best genotypes (Johnson et al., 1955). High genetic advance coupled with high heritability estimates offers the most suitable condition to decide selection criteria (Allard, 1960; Poehlman and Sleper, 1995; Syukur et al., 2012). Radwan and Abo El-Zahab (1972) estimated heritability from a combined analysis of variance of three progeny tests for multi-cut Egyptian clover. They obtained estimates of 26.0, 31.0, 30.0, and 39.0 % for green forage yield of the three successive cutting and seasonal crops, respectively. The Seed was sown broadcast with a seeding rate of 500gm were taken and dried to constant weight in an oven-controlled at 105°C, and percent of dry matter was calculated, and dry forage yield was determined. Seasonal fresh and dry products (ton acre⁻¹) were calculated by summation the result of four cuts at each season.

Data were subjected to regular analysis of variance (ANOVA) according to the method outlined by Gomez and Gomez (1984) using the MSTATC computer program (MSTATC, Michigan State Univ., 1992). L.S.D judged differences between means. Test at 5% probability levels. The variability present in the population was estimated by measure mean, range, phenotypic and genotypic variance. To estimate the phenotypic and genotypic variance, genotypic and phenotypic coefficients of variation were estimated based on the formula Syukur et al., (2012) as follow:

\[
\sigma^2_g = MS_g / \tau \\
\sigma^2_p = [(MS_p) – (MS_e)] / \tau \\
\sigma^2_e = MSe / r
\]

Where: \( \sigma^2_g \) = environmental variance; \( \sigma^2_p \) = Genotypic variance; \( \sigma^2_e \) = Phenotypic variance; \( MS_g \) = mean square of genotype; \( MS_p \) = mean square of error from the analysis of variance; \( MS_e \) = error mean square; \( r \) = number of replications.

Genotypic coefficient of variation (GCV) = \( [(\sigma^2_g) / \bar{X}] \times 100; \)

Phenotypic coefficient of variation (PCV) = \( [(\sigma^2_p) / \bar{X}] \times 100, \)

Where: \( \sigma^2_g \) = Genotypic variance; \( \sigma^2_p \) = Phenotypic variance; \( \bar{X} \) is grand mean of a character.

Broad sense heritability (\( h^2_b \)) of the all traits was calculated according to the formula as described by Allard (1960) as follow:

\[
h^2_b = [(\sigma^2_g) / (\sigma^2_p)] \times 100.
\]

Where: \( h^2_b \) = heritability in broad sense; \( \sigma^2_g \) = Genotypic variance; \( \sigma^2_p \) = Phenotypic variance.

Genetic advance (GA) was determined as described by Johnson et al., (1955):

\[
GA = K (\sigma_p) h^2_b
\]

Where: \( K \) = the selection differential (\( K = 2.06 \) at 5% selection intensity); \( \sigma_p \) = the phenotypic standard deviation of the character; \( h^2_b \) = broad sense heritability.

The genetic advance as percentage of the mean (GAM) was calculated as described by Johnson et al., (1955) as follow: \( \text{GAM} (\%) = (\text{GA} / \bar{X}) \times 100, \)

MATERIALS AND METHODS

The present study was carried out at the Experimental Station, Faculty of Agriculture, Cairo University, Giza, Egypt, during two successive winter seasons (2018/19 and 2019/20). In both seasons, ten varieties of Egyptian clover (Trifolium alexandrinum L.) were used. It’s namely, Hartuor, Narmar (these varieties were developed by agronomy Dept., Fac. of Agric., Cairo Univ.), Sinai 2, Giza 6, Helaly, Gemiza, Serw1, Sakha 4, Khadrawy and Meskawi (varieties developed by the Forage Res. Dept., Field Crop Res., Inst. ARC, Egypt). The experimental design was Randomized Complete Block Design (RCBD), with four replications. The plot size was 16m² (4x4). The experiments were sown on November 5th and November 28th for the first and second seasons, respectively. The Seed was sown broadcast with a seeding rate of 20 kg/acre. The recommended cultural practices of growing Egyptian clover were followed to raise average plant growth.

Four cuttings were taken in each season. The first cut was taken 60 days after sowing, and other cuts were taken at 40-day intervals in both seasons. At each cut, plant height (cm) was recorded on ten plants randomly taken from each plot. Whole plots were cut for fresh yield determination and converted to ton acre⁻¹. Samples of 500gm were taken and dried to constant weight in an oven-controlled at 105°C, and percent of dry matter was calculated, and dry forage yield was determined. Seasonal fresh and dry products (ton acre⁻¹) were calculated by summation the result of four cuts at each season.
Table 1: Mean squares of plant height for four cuts and seasonal fresh and dry yield at 1st and 2nd seasons.

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Degrees freedom</th>
<th>First season</th>
<th>Second season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Plant height</td>
<td>Seasonal forage yield (ton acre-1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cuts</td>
<td>Fresh Dry</td>
</tr>
<tr>
<td>Reps</td>
<td>3</td>
<td>21.50 52.89 4.09 29.68</td>
<td>50.25 3.110</td>
</tr>
<tr>
<td>Genotypes</td>
<td>9</td>
<td>13.21* 26.09* 54.83* 67.45*</td>
<td>9.82* 7.32*</td>
</tr>
<tr>
<td>Error</td>
<td>27</td>
<td>36.38 25.53 32.91 59.90</td>
<td>14.81 0.623</td>
</tr>
</tbody>
</table>

* = significant difference at $p < 0.05$.

Table 2: Ranges, means, and L.S.D0.05 of plant height for four cuts and seasonal fresh and dry yield at 1st and 2nd seasons.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Cuts</th>
<th>First Season</th>
<th>Second Season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ranges</td>
<td>Means L.S.D.0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max Min</td>
<td></td>
</tr>
<tr>
<td>Plant height (cm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>63.95 70.33</td>
<td>67.5 5.58</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>77.91 85.76</td>
<td>80.74 6.08</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>78.90 91.18</td>
<td>83.85 7.18</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>73.93 96.63</td>
<td>82.99 7.13</td>
</tr>
<tr>
<td>Seasonal forage yield (ton acre-1)</td>
<td></td>
<td>Fresh 114.70 137.72 125.20 4.63</td>
<td>120.26 162.07 146.89 4.23</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dry 20.72 26.52 24.31 0.95</td>
<td>25.10 29.84 28.65 1.02</td>
</tr>
</tbody>
</table>

Table 3: Estimates of genotypic variation ($\sigma^2g$), phenotypic variation ($\sigma^2p$), genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability in broad sense (h2b), genetic advance (GA), genetic advance as percentage of the mean (GAM) for studied traits of berseem at first and second seasons.

<table>
<thead>
<tr>
<th>Traits</th>
<th>First season</th>
<th>Second season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Plant height (cm) cut</td>
<td>Seasonal forage yield (ton/acre)</td>
</tr>
<tr>
<td></td>
<td>1 2 3 4 Fresh Dry</td>
<td>1 2 3 4 Fresh Dry</td>
</tr>
<tr>
<td>$\sigma^2G$</td>
<td>4.11 19.71 46.62 52.48 6.13 0.58</td>
<td>43.98 28.79 17.55 6.27</td>
</tr>
<tr>
<td>$\sigma^2P$</td>
<td>13.21 25.55 54.85 67.43 15.96 1.3</td>
<td>50.54 31.78 21.35 16.71</td>
</tr>
<tr>
<td>GCV (%)</td>
<td>3.00 5.49 8.15 8.73 1.98 3.13</td>
<td>11.34 7.56 5.71 2.56</td>
</tr>
<tr>
<td>PCV (%)</td>
<td>5.38 6.26 8.52 9.89 3.19 4.69</td>
<td>12.15 7.93 6.29 4.39</td>
</tr>
<tr>
<td>h2b (%)</td>
<td>31.11 77.14 84.99 77.83 38.41 44.62</td>
<td>87.02 90.59 82.20 37.52</td>
</tr>
<tr>
<td>GA</td>
<td>2.33 8.03 12.97 13.16 3.16 1.05</td>
<td>12.74 10.57 7.80 3.16</td>
</tr>
<tr>
<td>GAM %</td>
<td>3.45 9.95 15.46 15.86 2.52 4.31</td>
<td>21.78 14.79 10.66 3.23</td>
</tr>
</tbody>
</table>
RESULTS AND DISCUSSION

Variation of mean performance among berseem genotypes: The characterization of the genetic variation in the available germplasm is important for further improving crop yield and imparting resistance to biotic and abiotic stresses (Kour and Singh, 2004). The variance analysis in each season revealed that the mean squares due to berseem genotypes were significant for all studied traits, indicating the presence of sufficient variability in the material studied, and selection could be effective for improving those characters (Table 1). Similar results have also been reported by Bakheit and El-Hinnawy (1993), Badawy et al., (2018) and Salama, et al., (2020).

The average, minimum, and maximum values of the studied traits are shown in Table 2. A wide range of variation was observed for plant height traits. In the 1st season, the plant height had an overall mean and range of 67.5 and 92.23 to 98.25cm with a grand mean of 97.76cm. The range of plant height trait at the 4th cut was 73.93 to 96.63cm with a grand mean of 82.99cm. At the 3rd cut, plant height ranged from 68.88 to 77.00 with a grand mean of 73.39cm, while at the 4th cut, it ranged from 92.23 to 98.25cm with a grand mean of 97.76cm.

The extent of variability concerning seasonal forage yield in different diverse genotypes of berseem measured in terms of general mean and range for seasonal fresh and dry yields (Table 2). Berseem varieties had fresh seasonal yield ranging from 114.70 to 137.72 and averaging 125.20 ton acre⁻¹ in the first season. In the second season, the genotypes had a mean seasonal fresh yield of 146.89 with a range of 120.26 to 162.07 ton acre⁻¹. Seasonal forage dry yield of the varieties ranged from 20.72 to 26.53 with a grand mean of 24.31 ton acre⁻¹ in the first season, and it ranged from 25.10 to 29.84 with a grand mean of 28.65 ton acre⁻¹ in the 2nd season. A wider range of variation between thirty-two genotypes of berseem for plant height and dry matter was reported by Martiniello et al., (1992).

Seasonal dry yields of the ten berseem varieties in the 1st and 2nd seasons were shown in Figure (1). Concerning the total dry yield of the two seasons, variety khadrawy was the best (p>0.05), producing 26.52 and 32.18 ton acre⁻¹ in the 1st and 2nd seasons, respectively. Based on per se performance, the variety khadrawy was identified for total fresh and dry forage yields. Significant differences among berseem genotypes for different traits have been reported by Martiniello et al., (1992), Bakheit and El-Hinnawy (1993), El-Nahrawy et al., (2006), Zayed et al., (2011), and Abd El-Naby et al., (2015).

The estimates of phenotypic and genotypic variances, genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV), broad-sense heritability, genetic advance under selection and genetic advance as a percentage of the grand mean for studied traits of berseem varieties in two seasons are presented in Table (3). The GCV and PCV were computed to access the existing variability in the characters. The GCV values were ranged from 1.33 % for fresh seasonal yield in the 2nd season to 11.34% for plant height at the first cut. Similarly, the PCV values ranged from 1.86% for fresh seasonal yield in the 2nd season to 12.15% for plant height at the first cut in the 2nd season (Table 3). The values of PCV for different characters were higher than the corresponding GCV value. However, GCV was near to PCV for the characters like plant height at 2nd and 3rd cuts in the two seasons, seasonally fresh and dry yields in the second season (Table 3), indicating the high contribution of genotypic effect for phenotypic expression of such characters. A similar result was reported by Abo El-Goud et al., (2015). In other traits, there are relatively wider gaps between the estimate of PCV and GCV showed distinct contributions of environmental factors and genotypic effect for the expression of the traits.

Estimation of heritability is essential for plant breeders as it helps calculate the expected gains from any selection scheme (Falconer and Mackay, 1996). According to Singh (2001) that heritability values greater than 80% were very high, values from 60–79% were moderately high, values from 40–59% were medium, and values less than 40% were low. Accordingly, estimates of heritability were ranged from medium to moderately high for fresh seasonal yield in the two seasons, seasonal dry yield in 2nd season, and plant height at 2nd and 4th cuts in the first season. Estimates of heritability were high for plant height at the 3rd cut in the two seasons, plant height at the 1st and 2nd cuts, and seasonal dry yield in the second season. The characters having high heritability indicated a relatively small contribution of the environmental factors to the phenotype, and selection for such characters could be pretty easy due to the high additive effect. High estimates of broad-sense heritability have also been reported by Bakheit (1985) for plant height and seasonal dry yield and
by Zayed et al., (2011) for Dry yield of berseem. Genetic advance (GA) under selection referred to the improvement of characters in genotypic value for the new population compared with the base population under one cycle of selection at a given selection intensity (Singh, 2001). Hence, knowledge on heritability coupled with genetic advances is more beneficial. Estimates of GA values for all characters studied are displayed in Table 3. In the present investigation, high heritability values coupled with high genetic advance (Table 3) were recorded for plant height at 2nd and 3rd cut in the two seasons, at 4th cut in first season, and 1st cut in the second season, indicating these characters were controlled by additive gene effects and phenotypic selection for these characters is likely to be effective. Genetic advance as percent of the mean (GAM) was found to be the highest for plant height at 1st cut in the second season (21.78 %), followed by seasonal dry yield in 2nd season (16.07 %) (Table 3). According to Jonhson et al., (1955), high heritability estimates along with the high genetic advance as per mean is usually more helpful in predicting gain under selection than heritability alone.

**CONCLUSION**

Knowledge of the genetic variability of the Egyptian clover genotypes for the character under improvement is paramount for any plant breeding program’s success. A wide range variation was observed for plant height and forage yield traits of studied genotypes of berseem. High heritability values coupled with high genetic advances were recorded for plant height. This is usually more helpful in predicting gain under selection. Based on per se performance, the variety Khadrawy was identified for total fresh and dry forage yields.

**REFERENCES**


Statistical Programme. Michigan State Univ.


