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Research Article

Phenotypic Characterization of *Arundinella hirta* Plants in Korea

Chang-Woo Min, Il-Kyu Yoon, Min-Jun Kim, Myung-Ju Kim and Byung-Hyun Lee*
Department of Animal Bioscience, Division of Applied Life Science (BK21), IALS, Gyeongsang National University, Jinju 660-701, Republic of Korea

ABSTRACT

The present study was conducted to analyze agronomic characteristics of 8 ecotypes of *Arundinella hirta (A. hirta)* and the correlation among them. Changes in phenotypic characteristics of 8 ecotypes were measured at equal intervals of time from May to September. Among ecotypes, Jangsoo-1 has the highest plant height (172.33 cm), number of leaves (9.00) and leaf length (55 cm) while the ecotype Youngduk has the highest leaf width (1.57 cm), fresh mass (26.63 g), dry mass (7.06 g), number of spikelets per spike (53.33), amount of seeds per spike (0.74 g) and amount of seeds per 10 spikes (7.23 g). The ecotype Jinju-1 has the shortest plant height (119 cm) and leaf number (6.33), while Okgye-2 has shortest leaf length (30.67 cm), leaf width (0.93 cm), fresh mass (12.60 g), dry mass (3.30 g), spike length (30.33 cm), spikelet per spike (39.67), amount of seeds per spike (0.61 g) and amount of seeds per 10 spikes (6.00 g). Correlation coefficients were estimated among the studied agronomic characteristics which showed positive and significant association with each other. In the present study, the agronomic data collected would be useful to understand the potential of *A. hirta* as a forage resource and helpful in selecting the high-yielding genetic resource for future forage improvement.

(**Key words**: Agronomic characteristics, Correlation, Plant height, Leaf number, Seed yield)

Ⅰ. INTRODUCTION

Recently, the demand for high-quality animal foods has been increasing in Korea. For the purpose of raising the necessary livestock, large amounts of grain feed and hay are imported every year to supplement the insufficient domestic forage and grain feed. However, livestock farming that relies on imported feed not only has a negative impact on food security but can also cause unexpected events such as the outbreak of local war or a surge in grain prices, making it not a stable strategy for securing feed. Therefore, it is essential to develop breeds of feed crops or grasses that can be produced domestically under rapidly changing climatic and environmental conditions. Forage production and quality are greatly affected by soil, climatic conditions and seasonal factors (Costa et al., 2013). Therefore, collecting candidate genetic resources that are well adapted to the domestic climatic environment and have excellent feed value and analyzing their characteristics such as feed value analysis, agricultural characteristic analysis, and environmental disaster adaptability are very helpful in the development of new future grass varieties. *A. hirta* is a perennial grass species of grass family 60 to 150 cm tall. It is erect and can grow both from seeds and rhizomes. The general habitats are mountain slopes, riverbanks, and field margins and can be found in alpine grassland and are considered as useful for forage grass improvement and soil erosion control. It is distributed over Asian countries, Korea, China, Japan, India, and Taiwan (Umberto, 2012). Until now, there are very few studies that provide concrete and conclusive results about the variability of agronomic characteristics including the viability of *A. hirta* forage species. It is hypothesized that some of the ecotypes may outperform others in terms of herbage yield under a temperate environment. Thus, this study aimed to assess the agronomic characteristics and correlation among those characteristics, so that we can establish the criteria for selection of ecotypes that can be used in *A. hirta* breeding program in the future.

*Corresponding author: Byung-Hyun Lee, Department of Animal Bioscience, Division of Applied Life Sciences (BK21), IALS, Gyeongsang National University, Jinju 660-701, Republic of Korea.
Tel: +82-55-772-1882, E-mail: hyun@gnu.ac.kr

Ⅱ. MATERIALS AND METHODS

1. Collection and cultivation of Korean *A. hirta*

A. hirta seeds were collected from 8 regions of South Korea. Detailed information about collection regions are shown in Table 1. Seeds were sown in the experimental field of Gyeongsang National University Affiliated Animal Farm (128.14 East longitude, 35.20 North latitude) in Jinju South Korea in 2019. The plants were grown in a natural environment with no addition of artificial fertilizer or irrigation.

Table 1. Information for collection regions of Korean *Aundinella hirta*

Ecotype	Region	Latitude	Longitude
Jinju-1	Jinju	35°09'N	128°05'E
Nonsan-1	Nonsan	36°07'N	127°11'E
Yecheon	Yecheon	36°33'N	128°24'E
Gunsan	Gunsan	35°57'N	126°50'E
Jangsoo-1	Jangsoo	35°45'N	127°33'E
Yongduk	Yongduk	36°19'N,	129°16'E
Okgye-2	Okgye	36°19'N	129°15'E
Hamyang	Hamyang	35°29'N	127°44'E

2. Growth characteristics and productivity

The growth survey was started on 15 May 2020, measuring and observing agronomic characteristics such as plant height, leaf number, leaf length, leaf width, and fresh and dry weight per tiller. The data was collected once a month for consecutive five months after an equal interval of time. The height of the plant was measured from the ground surface to the tip of the plant and leaf numbers were counted from the first leaf from the base to the last leaf. The fresh weight of each ecotype was weighted by harvesting the whole plant at three replications in each plot. The dry mass was weighed after the samples collected at each harvest were dried at 65℃ for 72 h or more, in a hot air circulation dryer. The spike length was measured after full maturity and amount of seeds per spike and per 10 spikes were weighted after cutting the spikes at the end of October.

3. Statistical analysis

All data were presented as means ± SD for three replicates. The data among 8 local *A. hirta* ecotypes were analyzed by one-way (ANOVA). The differences among means were analyzed by a Tukey post-hoc test considered significant at $p<0.05$. All the analysis were conducted using SPSS, version 27.0 (SPSS Inc., Chicago, IL).

Ⅲ. RESULTS AND DISCUSSION

The present study was conducted to evaluate the agronomic characteristics of 8 local *A. hirta* ecotypes in Korea.

1. Plant height

Plant height in *A. hirta* ecotypes was the lowest 17 cm for Hamyang followed by Nonsan-1 (19 cm) and Okgye-2 (19.33 cm), the highest for Youngduk (31 cm), followed by Jinju-1 (26.67 cm) during the month of May (Table 2). During July the maximum increase in height was shown by Jangsoo-1 while minimum increase occurred in Okgye-2 (78 cm) and Nonsan-1 (85.67 cm). In August the maximum increase was noticed in

Table 2. Plant height of 8 local *A. hirta* ecotypes in Korea (cm)

Ecotype	May	June	July	August	September
Jinju-1	$26.67±1.53^{ab}$	$70.33±5.86^{c}$	$91.67±3.06^{c}$	$118.67±4.73^{d}$	$119.00±6.24^{d}$
Nonsan-1	$19±2.00^{bc}$	$67±2.65^{c}$	$85.67±4.73^{c}$	$141.00±3.61^{c}$	$143.00±3.00^{c}$
Yecheon	$20±4.36^{bc}$	$97.67±4.51^{ab}$	$108±2.65^{b}$	$152.33±4.04^{b}$	$152.67±3.51^{b}$
Gunsan	$24.33±4.73^{abc}$	$91±5.00^{b}$	$118.67±4.51^{bc}$	$142.33±3.51^{bc}$	$149.00±2.00^{bc}$
Jangsoo-1	$25.33±1.53^{ab}$	$102.33±1.53^{a}$	$133±8.54^{a}$	$172.67±2.08^{a}$	$172.33±0.58^{a}$
Youngduk	$31±3.00^{a}$	$94±3.00^{ab}$	$123.67±3.06^{a}$	$163.33±3.51^{a}$	$163.67±3.06^{a}$
Okgye-2	$19.33±1.53^{bc}$	$69.33±1.53^{c}$	$78±3.61^{c}$	$119.00±2.00^{d}$	$121.67±1.53^{d}$
Hamyang	$17±1.00^{c}$	$93.33±1.53^{ab}$	$122.67±9.07^{bc}$	$151.67±4.51^{b}$	$152.00±4.00^{bc}$

Data are expressed as means ± SD. Means with different superscripts in same rows differ significantly ($p<0.05$).

Jangsoo-1 (172.67 cm) followed by Youngduk (163.33 cm) while minimum increase was noticed in Jinju-1 (118.67 cm) and Okgye-2 (119 cm). The increase in height slowed down from August to September and the maximum height in September was that of Jangsoo-1 (172.33 cm) and minimum height of Jinju-1 (119 cm). The increase in plant height was faster from May to June and July, while it slowed down from August to September. This showed that the *A. hirta* gained maximum increase in height during June and July and hence these are the most critical months for the growth of *A. hirta*. In September the increase in plant height stopped as the plant reached its maturity. As long as the height is concerned, the ecotypes Jangsoo-1 and Youngduk are more superior to the other ecotypes. There is a close relationship between elements of yield and plant height, the ecotypes with high stature or height are desirable as forage crops to be cultivated. Hence in this study Jangsoo-1 and Youngduk are more desirable to be used as forage or energy crops in the future.

2. Leaf number and leaf length

The leaf numbers usually depend upon plant height. The more the height the more will be the leaves. Among the studied ecotypes the lowest number of leaves were produced by Okgye-2 (2.33) during the month of May while all the other ecotypes produced leaves 2.67 during the month of May (Table 3). During July the increase was more prominent and maximum in Jangsoo-1 (8.33) followed by Gunsan (7.33) and Youngduk (7.33). From July to August, the minimum increase occurred in Jinju-1 (6.33) while maximum increase occurred in Jangsoo-1 (9.0) followed by Gunsan (8.0). From August to September, no new leaves were produced and hence no increase in the number of leaves occurred. This result indicates that *A. hirta* plant reached its maximum number of leaves from May to August.

The leaf length of *A. hirta* ecotypes were measured from the month of May to September in order to recognize the ecotypes with maximum leaf length (Table 4). During May the minimum leaf length were that of Okgye-2 (18 cm) and maximum length

Table 3. Leaf number of 8 local *A. hirta* ecotypes in Korea

Ecotype	May	June	July	August	September
Jinju-1	$2.67±0.58^{a}$	$3.67±0.58^{a}$	$5.33±0.58^{c}$	$6.33±0.58^{b}$	$6.33±0.58^{b}$
Nonsan-1	$2.67±0.58^{a}$	$4.67±0.58^{a}$	$5.67±0.58^{c}$	$6.67±0.58^{b}$	$6.67±0.58^{b}$
Yecheon	$2.67±0.58^{a}$	$3.67±0.58^{a}$	$6.67±0.58^{bc}$	$7.67±0.58^{bc}$	$7.67±0.58^{bc}$
Gunsan	$2.67±0.58^{a}$	$3.67±0.58^{a}$	$7.33±0.58^{ab}$	$8.00±1.00^{bc}$	$8.00±1.00^{bc}$
Jangsoo-1	$2.67±0.58^{a}$	$4.67±0.58^{a}$	$8.33±0.58^{a}$	$9.00±1.00^{a}$	$9.00±1.00^{a}$
Youngduk	$2.67±0.58^{a}$	$4.67±0.58^{a}$	$7.33±0.58^{ab}$	$7.67±0.58^{bc}$	$7.67±0.58^{bc}$
Okgye-2	$2.33±0.58^{a}$	$3.67±0.58^{a}$	$6.33±0.58^{bc}$	$7.00±1.00^{bc}$	$7.00±1.00^{bc}$
Hamyang	$2.67±0.58^{a}$	$3.67±0.58^{a}$	$6.67±0.58^{bc}$	$7.67±0.58^{bc}$	$7.67±0.58^{bc}$

Data are expressed as mean ± SD. Means with different superscripts in same rows differ significantly ($p<0.05$).

Table 4. Leaf length of 8 local *A. hirta* ecotypes in Korea (cm)

Ecotype	May	June	July	August	September
Jinju-1	$18.33±1.53^{a}$	$37.67±3.06^{c}$	$38.00±2.00^{c}$	$40.00±1.00^{c}$	$40.00±1.00^{c}$
Nonsan-1	$19.33±1.53^{a}$	$38.33±3.51^{bc}$	$39±1.00^{c}$	$37.00±2.00^{c}$	$37.00±1.00^{c}$
Yecheon	$18.33±1.53^{a}$	$34.00±1.00^{cd}$	$36±1.00^{c}$	$36.00±2.00^{c}$	$36.33±3.06^{c}$
Gunsan	$19±1.00^{a}$	$45±1.00^{ab}$	$46.00±1.00^{b}$	$45.67±2.52^{b}$	$45.67±3.21^{b}$
Jangsoo-1	$19.33±1.53^{a}$	$48.33±1.53^{a}$	$53.00±1.00^{a}$	$54.67±0.58^{a}$	$55.00±1.00^{a}$
Youngduk	$20.33±1.53^{a}$	$37±4.00^{c}$	$45±2.00^{b}$	$46.67±3.21^{b}$	$47.00±1.00^{b}$
Okgye-2	$18±1.00^{a}$	$29.33±1.53^{d}$	$30±1.00^{d}$	$30.33±2.08^{d}$	$30.67±1.53^{d}$
Hamyang	$18.67±2.08^{a}$	$47.33±1.53^{a}$	$48±1.00^{b}$	$49.00±1.00^{b}$	$49.00±1.00^{b}$

Data are expressed as mean ± SD. Means with different superscripts in same rows differ significantly ($p<0.05$).

was that of Youngduk (20.33 cm) followed by Jangsoo-1 (19.33 cm). In June the minimum leaf length was that of Okgye-2 (29.33 cm), while maximum leaf length was that of Jangsoo-1 (48.33 cm). In July the minimum leaf length was that of Okgye-2 (30.0 cm), while the maximum leaf length was that of Jangsoo-1 (53.00 cm). In August the minimum leaf length was of Okgye-2 (30.33 cm) and maximum leaf length was of Jangsoo-1 (54.67 cm). During August to September the leaf length increased negligibly and the minimum leaf length was of Okgye-2 (30.67 cm) and maximum leaf length of Jangsoo-1 (55.00 cm). There are many factors to affect leaf length such as agricultural practices, climate and genotype. Beard (1973) reported that leaf length is primarily influenced by cell length. Although the number of cells has very little impact on leaf length, the length of day also increases leaf length, low intensity of the light and normal temperature have a positive impact on leaf length, but high or extreme temperatures have a negative influence on leaf length and shortage of water decreases the size and total area of the leaf (Hazard and Ghesquiere, 1997). The more yield is produced by long-leaved ecotypes in sparse mowing, while the short-leaved plants produce more yield in dense mowing.

3. Leaf width

Leaf width was minimum for Jinju-1 (0.40 cm) followed by Yecheon and Okgye-2 (0.50 cm) each, maximum for Gunsan (0.77 cm) followed by Nonsan-1 and Youngduk (0.70 cm) each in the month of May (Table 5). During August minimum leaf width was of Okgye-2 (0.90 cm) and maximum leaf width was of Youngduk (1.50 cm) followed by Gunsan (1.40 cm). In September minimum leaf width was of Okgye-2 (0.93 cm) and maximum of Youngduk (1.57 cm). *A. hirta* plants constitute the very rude leaf width. Leaf width is desired to be large for forage types while as thin as possible for turf types. Therefore, the differences between the averages of the leaf width provide the convenience of selecting desired plants.

Table 5. Leaf width of 8 local *A. hirta* ecotypes in Korea (cm)

Ecotype	May	June	July	August	September
Jinju-1	0.4±0.10^{b}	0.57±0.15^{b}	0.97±0.15^{cd}	1.1±0.10^{ab}	1.10±0.10^{bc}
Nonsan-1	0.7±0.10^{ab}	1.03±0.15^{a}	1.23±0.15^{abc}	1.3±0.15^{ab}	1.37±0.15^{ab}
Yecheon	0.5±0.10^{ab}	0.67±0.15^{ab}	1.1±0.10^{bcd}	1.2±0.10^{ab}	1.27±0.06^{abc}
Gunsan	0.77±0.15^{a}	0.93±0.15^{ab}	1.3±0.10^{ab}	1.4±0.06^{ab}	1.40±0.10^{ab}
Jangsoo-1	0.6±0.10^{ab}	0.73±0.12^{ab}	1.1±0.10^{bcd}	1.2±0.21^{ab}	1.30±0.20^{ab}
Youngduk	0.7±0.10^{ab}	1±0.10^{a}	1.5±0.10^{a}	1.5±0.15^{a}	1.57±0.06^{a}
Okgye-2	0.5±0.10^{ab}	0.53±0.15^{b}	0.8±0.10^{d}	0.9±0.15^{b}	0.93±0.15^{c}
Hamyang	0.57±0.15^{ab}	0.77±0.15^{ab}	1.3±0.10^{ab}	1.3±0.26^{ab}	1.30±0.10^{ab}

Data are expressed as mean ± SD. Means with different superscripts in same rows differ significantly (p<0.05).

Table 6. Fresh weight per tiller of 8 local *A. hirta* ecotypes in Korea (g/tiller)

Ecotype	May	June	July	August	September
Jinju-1	3.43±0.32^{b}	4.53±2.00^{b}	9.3±0.85^{d}	12.07±2.00^{d}	14.70±1.15^{d}
Nonsan-1	2.07±0.55^{b}	4.53±1.86^{b}	13.47±2.07^{dc}	16.23±1.60^{cd}	16.33±0.21^{de}
Yecheon	2.37±1.12^{b}	9.17±4.62^{ab}	16.03±2.25^{bc}	17.47±2.49^{bc}	18.37±0.31^{c}
Gunsan	2.50±0.95^{b}	8.17±3.81^{ab}	20.7±3.12^{ab}	21.47±1.30^{b}	21.53±0.31^{b}
Jangsoo-1	3.13±0.15^{b}	10.4±4.13^{a}	20.2±2.35^{ab}	16.43±0.80^{cd}	16.60±0.10^{cd}
Youngduk	6.57±0.78^{a}	10.53±5.93^{a}	24.53±2.70^{a}	26.53±1.88^{a}	26.63±0.25^{a}
Okgye-2	2.07±0.47^{b}	6.37±3.06^{ab}	9.33±1.62^{d}	12.57±0.91^{d}	12.60±0.10^{f}
Hamyang	1.80±0.10^{b}	7.7±3.97^{ab}	13.93±0.87^{dc}	20.57±1.25^{bc}	20.60±1.37^{b}

Data are expressed as mean ± SD. Means with different superscripts in same rows differ significantly (p<0.05).

Table 7. Dry weight per tiller of 8 local *A. hirta* ecotypes in Korea (g/tiller)

Ecotype	May	June	July	August	September
Jinju-1	$1.10±0.20^{ab}$	$1.33±0.15^{b}$	$2.67±1.12^{c}$	$3.53±0.59^{de}$	$3.53±0.49^{e}$
Nonsan-1	$0.57±0.21^{b}$	$1.2±0.26^{b}$	$3.87±0.68^{abc}$	$3.90±0.10^{cde}$	$3.87±0.25^{de}$
Yecheon	$0.63±0.49^{b}$	$2.63±0.40^{a}$	$4.13±0.90^{abc}$	$5.70±0.20^{b}$	$5.80±0.20^{b}$
Gunsan	$0.80±0.44^{b}$	$2.23±0.50^{ab}$	$6.2±1.04^{a}$	$6.63±0.21^{a}$	$6.75±0.11^{a}$
Jangsoo-1	$1.10±0.10^{ab}$	$2.93±0.55^{a}$	$5.9±1.64^{ab}$	$4.27±0.15^{cd}$	$4.42±0.14^{cd}$
Youngduk	$1.77±0.15^{a}$	$2.27±0.32^{ab}$	$5.67±1.61^{abc}$	$6.80±0.20^{a}$	$7.06±0.07^{a}$
Okgye-2	$0.60±0.20^{b}$	$1.77±0.47^{ab}$	$2.8±0.79^{bc}$	$3.27±0.15^{e}$	$3.30±0.10^{e}$
Hamyang	$0.50±0.10^{b}$	$2.20±0.53^{ab}$	$4.33±0.45^{abc}$	$4.60±0.20^{c}$	$4.67±0.25^{c}$

Data are expressed as mean ± SD. Means with different superscripts in same rows differ significantly ($p<0.05$).

4. Fresh and dry mass

Fresh mass of tiller was minimum for Hamyang (1.8 g) followed by Nonsan-1 and Okgye-2 (2.07 g) while maximum for Youngduk (6.57 g) followed by Jinju-1 (3.43 g) in May (Table 6). The minimum fresh mass in September was of Okgye-2 (12.60 g) and maximum for Youngduk (26.63 g). The increase in fresh mass was higher from the month of May to June and July and less from July to August and September. Dry mass of tiller was minimum for Hamyang (0.5 g) followed by Nonsan-1 (0.57 g) while maximum for Youngduk (1.77 g) followed by Jangsoo-1 (1.1 g) in May (Table 7). In a similar manner to fresh mass, the minimum dry mass in September was Okgye-2 (3.30 g), and the maximum was for Youngduk (7.06 g). Fresh and dry mass are essential for forage crops, the more fresh and dry mass produced by an ecotype the more nutrients in them and hence will be preferred to cultivate as forage.

5. Spike length, number of spikelets, and seed yield

Spike length is directly related to the seed yields. Longer the spike more will be the amount/number of seeds. The longest spike was that of Youngduk (40 cm) followed by Gunsan (39.0 cm), while the lowest were of Okgye-2 (30.33 cm), followed by Nonsan-1 (34.0 cm) (Table 8). The spike length is influenced by genotype, environment, and agricultural practices. Acar et al. (2010) described that spike length was an important feature for seed yield. Spike length was not only important for the determination of the level of generative organ development but it is also known that the longer the spike in the grass, the higher the seed (Okkaoglu, 2006). The spikelet per spike is another aspect that is related to seed yield. The largest number of spikelets per spike were of Youngduk (53.33), followed by Jangsoo-1. It is reported that genotype affected the number of spikelets per spike in contrast to environment (Okkaoglu, 2006). Our results are also in accordance with Okkaoglu (2006), who reported that the

Table 8. Spike length, number of spikelet per spike and amount of seed yield of 8 local *A. hirta* ecotypes in Korea

Ecotype	Spike length (cm)	Spikelet per spike	Amount of seeds per spike (g)	Amount of seeds per 10 spikes (g)
Jinju-1	$34.33±1.53^{c}$	$47.67±3.06^{ab}$	$0.72±0.09^{ab}$	$6.33±0.15^{ef}$
Nonsan-1	$34.00±1.00^{dc}$	$48.00±2.00^{ab}$	$0.69±0.02^{b}$	$6.80±0.10^{bc}$
Yecheon	$34.33±1.53^{c}$	$47.67±3.06^{ab}$	$0.66±0.03^{b}$	$6.37±0.15^{def}$
Gunsan	$39.00±1.00^{ab}$	$49.33±1.53^{ab}$	$0.70±0.02^{ab}$	$6.77±0.15^{bcd}$
Jangsoo-1	$38.33±1.53^{ab}$	$53.00±2.00^{ab}$	$0.73±0.02^{a}$	$7.00±0.20^{ab}$
Youngduk	$40.00±1.00^{a}$	$53.33±2.08^{a}$	$0.74±0.02^{a}$	$7.23±0.15^{a}$
Okgye-2	$30.33±1.53^{d}$	$39.67±2.08^{c}$	$0.61±0.01^{b}$	$6.00±0.10^{f}$
Hamyang	$35.33±1.53^{bc}$	$47.00±1.00^{b}$	$0.67±0.03^{ab}$	$6.57±0.15^{cde}$

Data are expressed as mean ± SD. Means with different superscripts in same rows differ significantly ($p<0.05$).

number of spikelets per spike has a positive and high effect on seed production. The highest amount of seeds per spike was produced by Youngduk (0.74 g) followed by Jangsoo-1 (0.73 g), while the highest amount of seeds per 10 spikes were produced by Youngduk (7.23 g) and followed by Jangsoo-1 (7.0 g). Seed yield per spike depends upon number of flowers in spikelets, number of spikelets, grain weight and fertile flower number. Some of these were controlled by genetics while others by environmental factors. From the results of spike length, number of spikelets per spike, amount of seeds per spike, and amount of seeds per 10 spikes it is concluded that Youngduk and Jangsoo-1 are the high-yielding ecotypes as compared to the other ecotypes.

6. Simple correlation coefficients (r) among agronomic characteristics of *A. hirta*

Analysis of the correlation coefficients of the agronomic characteristics in *A. hirta* is shown in Table 9. It was observed that plant height is positive and strongly significantly correlated with the fresh mass (r = 0.629), dry mass (r = 0.590), leaf length (r = 0.737), leaf number (r = 0.672), spike length (r = 0.716), number of spikelets per spike (r = 0.718), amount of seeds per 10 spikes (r = 0.755). Similarly, fresh mass was found to be positive and significantly correlated with dry weight (r = 0.869), leaf width (r = 0.779), spike length (r = 0.768), and amount of seeds per 10 spikes (r = 0.711). Dry mass also showed a positive and significant correlation to phenotypic characteristics in a similar manner to fresh mass. Leaf length is positive and significantly correlated to leaf number (r = 0.746), number of spikelet per spike (r = 0.724) and amount of seeds per 10 spikes (r = 0.707). Spike length is positive and significantly correlated with number of spikelets per spike (r = 0.844), and amount of seeds per 10 spikes (r = 0.845).

In this study, we focused on the agronomic characteristics and seed yield in order to select a good candidate for forage and seed yield in the future. Correlation and path-coefficient analyses are successful tools for the development of the selection criteria (Diz et al., 1994). Since our *A. hirta* study is mainly focused on an increased and better forage yield, in the present study, we performed correlation analyses on certain major agronomic characteristics and seed yield. It was observed that the plant height, spike length, leaf length, leaf width, and seed yield have positive and significant correlations. Our results are in concordance with the previous findings from studies on *Lolium perenne* (Jian et al., 2000). Jian et al. (2000) reported a positive correlation of seed yield with spikelet numbers per spike, spike length, and seed number per spike, but negative correlation with plant height. It was also demonstrated that leaf length is a good selection criterion to be used for the improvement of the *Lolium* cultivars with higher dry matter yield (Pourmoradi and Mirzaie, 2011).

Table. 9. Simple correlation coefficients (r) among agronomic characteristics of 8 local *A. hirta* ecotypes in Korea

	1	2	3	4	5	6	7	8	9	10
1	1									
2	0.629**	1								
3	0.590**	0.869**	1							
4	0.737**	0.505*	0.375	1						
5	0.674**	0.779**	0.662**	0.490*	1					
6	0.672**	0.294	0.366	0.626**	0.435*	1				
7	0.716**	0.768**	0.715**	0.746**	0.744**	0.450*	1			
8	0.718**	0.624**	0.500*	0.724**	0.730**	0.417*	0.844**	1		
9	0.449*	0.480*	0.292	0.579**	0.618**	0.254	0.715**	0.874**	1	
10	0.755**	0.711**	0.546**	0.707**	0.794**	0.405*	0.845**	0.890**	0.768**	1

**. Correlation is significant at the 0.01 level. *. Correlation is significant at the 0.05 level.

Note: 1: Plant height, 2: Fresh weight, 3: Dry weight, 4: Leaf length, 5: Leaf width, 6: Leaf number, 7: Spike length, 8: Number of spikelet per spike, 9: Amount of seeds per spike, 10: Amount of seeds per 10 spikes.

Ⅳ. CONCLUSIONS

The results from this study revealed that significant variability exists among ecotypes of *A. hirta* under study in terms of their agronomic characteristics. The highest plant height, leaf number, and leaf length were observed in Jangsoo-1, higher leaf width, fresh mass, dry mass, spikelets per spike, amount of seeds per spike, and amount of seeds per ten spikes were in Youngduk. This indicates that Jangsoo-1 and Youngduk have better agronomic characteristics for forage resources than the other ecotypes. There is considerable potential in Jangsoo-1 and Youngduk for selecting as forage in the future, which have adequate agronomic characteristics to improve forage. Additional studies are needed to analyze the nutritional value of *A. hirta* ecotypes in the future. *A. hirta* could be used as a genetic resource to develop new cultivars with a higher potential for forage production in Korea.

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