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Determination of Some Physiological Characters in Forage Plants

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Abstract: This study was conducted at research and experimental areas of Bahri Dagdas International Agricultural Research Institute. For the experiment, 8 forage plants were used (all plants with a C_3 type of photosynthesis and they were grown under some conditions). The experiment was laid out Randomized Complete Block design with four replications. We analyze importance of the growth parameters Relative Growth Rate (RGR), Net Assimilation Rate (NAR), Leaf Area Rate (LAR), Leaf Weight Rate (LWR) and Root Weight Rate (RWR). A large variation in physiological characters between species was observed. Slow-growing species had a constant RGR, NAR and LAR in early stages. Genotypic variation in physiological characters may be an explanation for the observed.

Key words: Net assimilation rate, relative growth rate, leaf area rate, root weight rate, forage plants, growth rate

INTRODUCTION

Forage plants may differ in biomass production. This can be by seed largeness and length of growing period or environmental factors. In addition, physiological characters relative growth rate, net assimilation rate, leaf area rate may vary among forage plants. Plant ecophysiologists commonly measure these characters as indicators of plant response to the environment (Bazzaz, 1996). Grime and Hunt (1975) compared 130 herbaceous annuals, perennials and tree seedling, all from local flora. Although, all species were grown under uniform and more or less optimal conditions, there was a large variation in growth rate.

The Relative Growth Rate (RGR) is product of Net Assimilation Rate (NAR) and Leaf Area Ration (LAR). NAR is largely net results of carbon gain (photosynthesis) and carbon loses (respiration, exudation, volatilization) expressed per unit leaf area (Poorter and Ramkes, 1990). Dijkstra ans Lambers (1986) and Smeets and Garratsen (1986) found interspesific variation in RGR to be due to differences in LAR.

Forage plants show different growth pattern. For plants growing uncontrolled conditions, physiological characters of growth varied significantly. To obtain more insight in the causation of physiological differences in growth rate, a comparison including more species and covering a wider range of RGR's is needed.

A agronomic practices and planting technique are considerable importance as proper adjustment of plants in the field not only ensures optimum sowing time but also enables the plants to utilize the land and other input resources more efficiently and resolutely towards growth and development (Ali *et al*., 1998). Charles-Edwards and Fischer (1980) and Sheehy *et al*. (1980) said that crop growth rate depends on canopy characteristic. That it is independent of plant species within the canopy.

The LAR is the ratio of leaf area and total plant weight and is the production of a morphological component, the ratio of leaf area weight and leaf weight ratio, indicating the fraction of total plant weight allocated to the leaves (Poorter and Ramkes, 1990). Palta *et al*. (2007), P-3394 and C-955 maize varieties growth analysis were made depending on time. In growth analysis, leaf area index, plant growth ratio, dry matter and net assimilation ratio were estimated.

As results, C-955 cultivar was higher performance of physiological characters than P-3394 cultivar. This study presents data on the growth of 8 forage plants, all plants with a C_3 type of photosynthesis and they were grown under some conditions. We analyze importance of the growth parameters Relative Growth Rate (RGR), Net Assimilation Rate (NAR), Leaf Area Rate (LAR), Leaf Weight Rate (LWR) and Root Weight Rate (RWR).

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Table 1: Forage plants used in the experiment, life form and main habitat

Species	Life form	Habitat
Lolium perenne L.	Perennial	Nutrient-rich grassland
Phleum pratense L.	Perennial	Hay meadow on sand
Dactylis glomerate L.	Perennial	Nutrient-rich hay meadow
Festuca ovina L.	Perennial	Dry, nutrient poor sand
Trifolium repens L.	Perennial	Frequently trampled or grassland
Medicago sativa L.	Perennial	Nutrient-rich grassland
Origanum vulgare L.	Perennial	Calcareous grassland
Onobrychis sativa L.	Perennial	Dry places, calcareous grassland

MATERIALS AND METHODS

For the experiment 8 forage plants were used. Table 1 present these plants, together with main habitat. This experiment was conducted at research and experimental areas of Bahri Dagdas International Agricultural Research Institute. The experiment was laid out Randomized Complete Block design with four replications.

The net plot size measured 1.6×5 m. The soil was loam, 0.063% total N, low in available phosphorus (25.5 kg P ha^{-1}) and medium in available potassium (213 kg K ha^{-1}). A uniform basal application of diamonium phosphate (18% N and 46% P_2O_5) was made at the rate of 150 kg ha^{-1} (in graminea) and 120 kg ha^{-1} (others).

The experiment started when plants reached until approximately 5 cm height (day 0). Harwest carried out at day 0, 5, 10, 15, 20 and 25. Each day 3 plants were selected at each plot as described by Poorter (1989) and harvested plants were separated as root, stem and leaves.

Dry matter weights of plants were determinated on oven-dried (24 h at 80°C). Data were analyzed with SAS statistical package program. Differences in physiological characters were tested as an analysis of variance. Relation between the several parameters and dry matter were tested regression equation.

RESULTS AND DISCUSSION

Plant species differed significantly ($p<0.001$) in all physiological characters and dry matter yield (Table 2). *Festuca ovina* has higher value RGR, NAR, LAR and RWR than other plants. But, *Medicago sativa* has the lowest LWR. High correlation was found dry matter and all physiological characters. RGR differed from 188 mg/g/day for *Origanum vulgare* to 228 mg/g/day for *Festuca ovina*.

Dry matter weight also varied considerably between species, ranging from 5.8 mg for *Origanum vulgare* to 11.5 for *Festuca ovina*. Larger plants tend to have a lower RGR, due to self-shading (Poorter *et al*., 1988). It is founded to be a correlation between dry matter and net assimilation rate is more than others (Fig. 1).

The NAR ranged from 8.3 g/m^2/day for *Phleum pratense* to 14 g/m^2/day for *Festuca ovina*. A slightly positive correlation was found between NAR and RGR, but it is not statistically significant.

The LAR showed different pattern. The fastest growing species had an almost two times higher LAR than the slowest growing ones. There is a positive correlation, on between LAR and RGR. But the correlation RGR and LWR is weak. RWR showed no clear correlation with RGR. The leaf area and root length ratio varied and increased with increasing RGR.

A large variation in physiological characters between species was observed. Slow-growing species had a constant RGR, NAR and LAR in early stage. Genotypic variation in physiological characters may be an explanation for the observed differences (Roetman and Sterk, 1986; Poorter and Ramkes, 1990).

This research shows plants invest in leaf area, the higher total carbon gain and the faster growth will be. This was also found in some studies (Roetman and Sterk, 1986; Dijkstra and Lamberts, 1986; Poorter, 1989; Poorter and Ramkes, 1990). There is negative correlation between NAR and LAR.

This is mainly caused by a negative correlation between NAR and LWR. There is a distinction between graminea and legumes with regard to this aspect; fast growing graminea invest relatively more in leaves and less in stem and roots than slow-growth legumes. It is also important in plant ecophysiologists to evaluate genetic regulation of these traits in order to understand the mechanism by which plants have adapted to divers environments.

The balance between shoot and root can be derived from LWR on the shoot to root ratio. The ratio depends on leaf morphology, biomass allocation and specific root length.

In the nutrient-rich environment dense vegetation with a high leaf index will develop. The maximum light interception in such an environment with strong competition for light; species have allocate relatively much to above ground biomass (Poorter and Ramkes, 1990). Moreover, new leaves develop very fast during a short period of growing season.

Table 2: Values of DM, RGR, NAR, LAR, LWR and RWR

Species	DM	RGR	NAR	LAR	LWR	RWR
Lolium perenne L.	9.4b	209b	14.0a	22.1c	0.52a	0.36b
Phleum pratense L.	8.5b	222a	8.3c	26.3a	0.51a	0.34c
Dactylis glomerate L.	8.0c	224a	8.9bc	24.4b	0.46b	0.38a
Festuca ovina L.	7.5c	228a	9.0bc	24.7ab	0.46b	0.39a
Trifolium repens L.	8.1bc	204b	10.6b	20.9c	0.40d	0.26e
Medicago sativa L.	7.0c	193c	9.0bc	19.5d	0.38e	0.23f
Origanum vulgare L.	5.8d	188c	9.8b	17.9e	0.34f	0.23f
Onobrychis sativa L.	11.2a	207b	10.6b	20.6cd	0.42c	0.29d

All values are mean values for the time periods

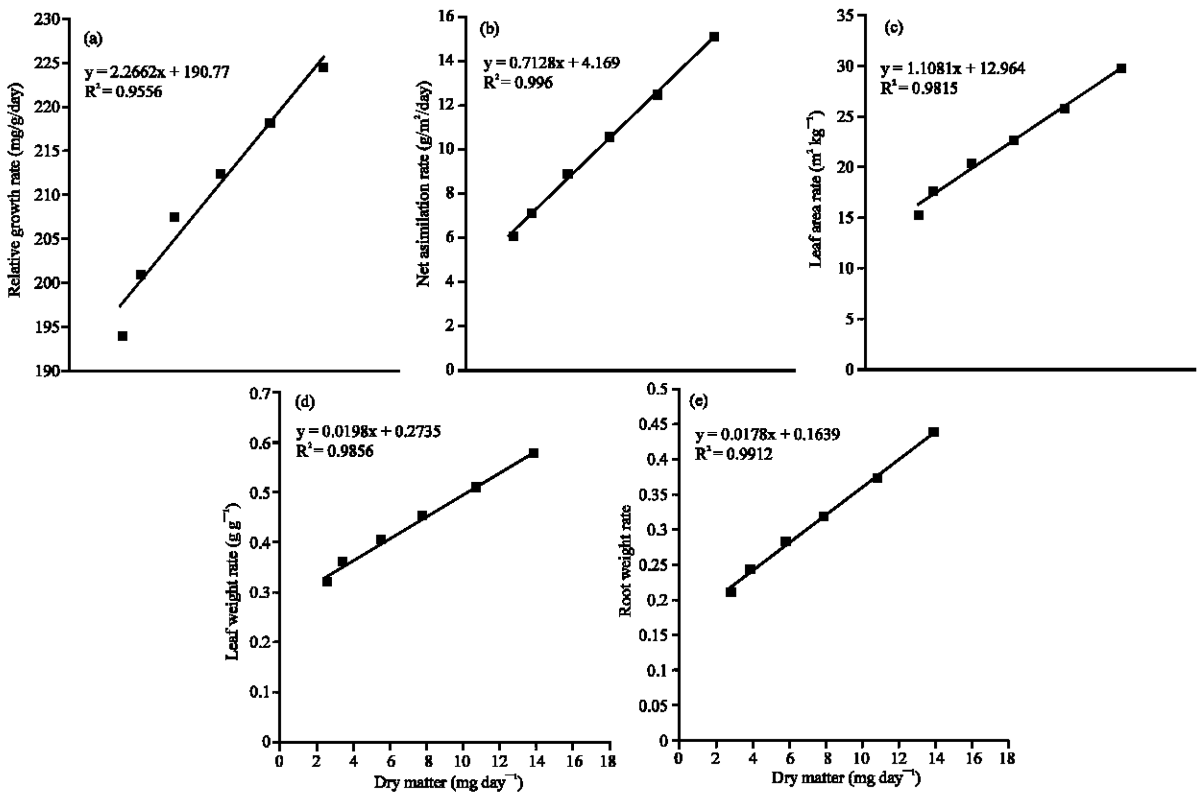

Fig. 1: Relation between dry matter and physiological characters. a): Relative growth rate and dry matter, b): Net assimilation rate and dry matter, c): Leaf are rate and dry matter, d): Leaf weight rate and dry matter, e): Root weight ratio and dry matter

CONCLUSION

This research shows plants invest in leaf area, the higher total carbon gain and the faster growth.

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