International Journal of Farm Sciences **8(1):** 9-12, 2018; doi: 10.5958/2250-0499.2018.00003.4

Growth and forage yield evaluation in different cultivars of *Festuca arundinacea* and *Setaria anceps*

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Received: 6.12.2016/Accepted: 17.5.2017

ABSTRACT

Three cultivars viz HIMA-4, Hima-1 and EC-178182 of tall fescue grass (*Festuca arundinacea*) and three cultivars viz S-18, S-92 and PSS-1 of *Setaria anceps* were introduced from Indian Grassland and Fodder Research Institute, Palampur, Kangra, Himachal Pradesh and planted in the field of Directorate of Extension Education, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during August 2014 for growth and forage yield evaluation. Trials were laid out in split plot design with three replicates using spacing in the main plot and the varieties in the sub-plots. There were 54 plots of 2 x 1 m accommodating all the possible treatment combinations. Significant variation was observed for growth and yield parameters in all the cultivars under investigation. Yield efficiency as influenced by clump cross-sectional area and clump canopy volume at various planting densities were also computed and are presented.

Keywords: *Festuca*; *Setaria*; forage crops; growth; yield efficiency

INTRODUCTION

Livestock provides drought power, rural transport, organic manure, fuel cakes, milk, meat etc. Most often livestock is the only source of cash income for subsistence farms and also serves as insurance in the event of crop failure. India's livestock sector offers considerable scope for enhancement. The milk production by Indian livestock is much below as compared to United States and Israel. The low productivity of Indian livestock is a matter of concern which is mainly due to inadequate supplies of quality feed and fodder. Thus an attempt has been made to evaluate different cultivars of forage crops for growth, yield potential and yield efficiency as influenced by clump cross-sectional area and clump canopy volume at various planting densities in order to select the best cultivar capable of giving higher forage yield.

MATERIAL and METHODS

The experiment was conducted by planting three cultivars viz HIMA-4 (T_1), HIMA-1 (T_2) and EC-178182 (T_3) of tall fescue grass (*Festuca arundinacea*) and three cultivars viz S-18 (T_4), S-92 (T_5) and PSS-1 (T_6) of setaria (*Setaria anceps*). Two slips of each cultivar were planted in the field of Directorate of Extension Education, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during August 2014 at 60 x 30, 60 x 45 and 60 x 60 cm spacing in well prepared field supplemented with good quality farmyard manure at the rate of 150 q/ha. Trials were laid out in split plot design with three replicates using spacing in the main plot and the varieties in the sub-plots. There were 54 plots of 2 x 1 m accommodating all the possible treatment combinations. The data on tillers per plant, tiller height and forage yield per plot were recorded after one year under each treatment and replication. The recoded data for yield were projected in quintal per hectare. Tiller height was recorded with a meter stick for all the individuals under each treatment and replication and average was calculated. The slip survival percentage was recorded by counting the alive slips 6 and 12 months after transplanting and average values were computed. The clump cross-sectional area was computed by square of the clump girth divided by the 4 pie. Clump canopy volume was estimated by the formula equal to pie multiplied by the square of radius of clump which was again multiplied by the plant height divided by three.

RESULTS and DISCUSSION

Various spacing treatments significantly affected growth and forage yield parameters in different cultivars (Table 1). Decrease in planting density showed direct proportional relationship with tiller height and inverse relation to tillers per plant, forage yield due to lack of competition for growth resources at low planting density and vice versa. Planting density influences local environment and growth attributes of plants. Competition is the most frequent reason for reduced forage yields as reported by Szott et al (1991) that supports the present finding. Maximum forage yield (420.8 q/ha) was recorded in PSS-1 cultivar of setaria (T_6) which was significantly different from all other cultivars except S-92 of Setaria (T_5) at S_1 planting density (60 x 30 cm). Minimum yield (405.4 q/ha) was recorded in EC-178182 of *Festuca arundinacea* (T_3) indicating non-significant differences with T_1 and T_2 treatment combination that may be due to the genetic make-up of the genotypes performing same yield potential at S_1 planting density ie high planting density. Tiller height and leaf length were observed maximum at low planting density ie 60 x 30 cm and were found reducing with reduction in planting density due to lack of competition for growth

Table 1. Vegetative growth and yield of forage crops as affected by different spacing

Treatment (T)	Survival (%)	Tillers/plant	Tiller height (cm)	Clump spread (cm)		CG (cm)	Yield (q/ha)	Leaf length (cm)
				E-W	N-S			
60 x 30 cm (S_1)								
T_1	85.6	22.6	45.4	24.4	27.4	42.9	408.6	42.6
T_2	86.7	21.7	46.7	25.6	27.6	41.8	406.7	43.8
T_3	87.8	20.1	48.2	26.8	28.8	40.7	405.4	44.9
T_4	88.9	30.6	35.6	24.4	29.4	43.5	415.6	37.6
T_5	87.8	32.7	38.9	25.2	26.7	41.7	418.6	36.8
T_6	86.4	31.3	40.2	25.8	24.8	40.8	420.8	35.4
Mean	87.2	26.5	42.5	25.4	27.5	41.6	412.6	41.2
CV (%)	0.64	9.83	7.31	2.94	1.89	2.03	0.57	4.19
$LSD_{0.05}$	0.95	4.43	5.29	1.27	0.88	1.45	4.05	2.87
60 x 45 cm (S_2)								
T_1	87.8	25.2	42.5	26.5	28.6	43.7	406.4	40.3
T_2	88.6	24.8	42.7	28.2	29.5	42.3	407.2	41.1
T_3	90.3	22.6	40.4	30.8	30.7	41.7	408.7	42.4
T_4	91.4	34.4	34.9	25.8	30.6	44.4	412.1	36.4
T_5	92.6	36.4	36.5	26.9	27.8	42.8	416.8	35.7
T_6	92.4	35.8	38.3	26.5	26.5	41.3	418.7	34.8
Mean	90.5	29.9	39.2	27.5	28.9	42.7	411.6	39.5
CV (%)	0.29	9.2	3.78	4.83	1.47	2.17	0.12	3.56
$LSD_{0.05}$	0.45	4.68	2.53	2.26	0.72	1.58	0.86	2.33
60 x 60 cm (S_3)								
T_1	91.8	28.4	40.3	27.2	29.1	44.6	410.8	40.8
T_2	92.7	27.6	41.6	29.8	30.8	43.8	412.8	41.7
T_3	93.6	25.4	39.8	32.4	32.6	42.9	413.7	40.5
T_4	92.6	38.7	32.5	27.6	31.4	45.8	416.8	33.7
T_5	93.8	40.2	33.8	28.8	29.3	44.1	418.7	34.7
T_6	94.2	39.7	35.3	27.9	27.6	42.6	420.9	33.3
Mean	93.1	33.3	37.2	28.9	31.1	43.9	415.6	37.5
CV (%)	0.40	9.35	5.22	4.95	2.35	2.08	0.05	4.08
$LSD_{0.05}$	0.65	5.31	3.31	2.44	1.21	1.56	0.39	2.61

E-W= East-West, N-S= North-South, CG= Clump girth; HIMA-4 (T_1), HIMA-1 (T_2), EC-178182 (T_3) of tall fescue grass (*Festuca arundinacea*); S-18 (T_4), S-92 (T_5), PSS-1 (T_6) of setaria (*Setaria anceps*)

Table 2. Comparative yield efficiency as influenced by CCSA and CCV at various planting densities

Treatment (T)	Spacing (cm)					
	60 x 30		60 x 45		60 x 60	
	Y/CCSA (kg/cm^2)	Y/CCV (kg/m^3)	Y/CCSA (kg/cm^2)	Y/CCV (kg/m^3)	Y/CCSA (kg/cm^2)	Y/CCV (kg/m^3)
T_1	2.78	18.42	2.67	18.86	2.59	19.30
T_2	2.92	18.78	2.85	20.08	2.70	19.49
T_3	3.07	19.13	2.95	21.92	2.82	21.28
T_4	2.75	23.24	2.62	22.57	2.49	23.03
T_5	3.02	23.31	2.85	23.48	2.70	24.00
T_6	3.17	23.69	3.08	24.15	2.91	24.75
Mean	2.95	21.1	2.83	21.8	2.70	21.9
CV (%)	3.52	3.96	4.23	0.57	4.11	1.39
$LSD_{0.05}$	0.18	0.52	0.20	0.23	0.19	0.52

Y= Yield, CCSA= Clump cross-sectional area, CCV= Clump canopy volume; HIMA-4 (T_1), HIMA-1 (T_2), EC-178182 (T_3) of tall fescue grass (*Festuca arundinacea*); S-18 (T_4), S-92 (T_5), PSS-1 (T_6) of setaria (*Setaria anceps*)

resources at low planting density. Results reported by Szott et al (1991) support these findings. At higher planting density of 60 x 30 cm when light is not a limiting factor the plants tend to grow more in height for capturing solar light. These findings indicated that at low planting density the forage plants under investigation tended to grow towards light producing higher number of tillers, crown spread and crown girth which ultimately gave significantly higher forage yield as compared to high planting density. The findings of Sharma (1989) support the present results. The spacing is recommended to create expected variation between species/cultivars and determines yield per plant rather yield per unit area (Tarawali et al 1995). Forage crops provide better diversification options particularly for dry land farming specifically having low precipitation compared to grain crops. These crops have greater water use efficiency and less susceptibility to devastating yield reduction due to water stress during critical growth stages. However a researcher needs a simple tool to evaluate forage productivity under varying planting densities (Alkhamisi et al 2011). Review study of cropping systems reported by Nielsen et al (2005) indicated that systems utilizing forages generally had greater precipitation use efficiency (based on both mass produced per unit of precipitation received and gross value of product per unit of precipitation received) than systems that did not include forages.

The life cycles of forage plants are the characteristics of distinct changes in plant morphology. The ontogeny of most forage plants involves seedling, vegetative and reproductive stages of development. These occur in a predictable manner and are useful for describing the maturity of individual plant as well as population or stand. The close relationship between leaf and tiller initiation makes it possible to mathematically describe tiller production as a function of leaf appearance rate and of site filling which provides a measure of the ability of axillary buds to develop into new tillers assuming that buds are produced in each leaf axil and that each bud has the potential to develop into a new tiller ie fill the site. Davis (1974) determined that tiller number can potentially increase by a factor of 1.618 during each leaf appearance interval on the main stem. However Neuteboom and Lantinga (1989) reported that tiller buds can also develop in the axil of prophyll which is a small scaly leaf at the base of each tiller.

When prophyll tillers are taken into account tiller number has the potential to increase by a factor of 2.0 for each leaf appearance interval. In other words the number of tillers per plant can double with the appearance of each new leaf on the main stem. This potential tiller appearance rate assumes that the new tillers appear in the axil of the second youngest fully emerged leaves on the parent tillers. An analogous concept to site filling called nodal probability with values ranging between 0-1 has been developed to describe the probability of a tiller developing at any individual site (Mathew et al 1998). They further suggested that higher the number of tillers per plant higher will be the forage yield efficiency exempting the height of the tiller.

Yield efficiency under the influence of clump cross-sectional area was recorded maximum (3.17 kg/cm^2) in T_6 cultivar of *S anceps* though at par with T_5 cultivar of *S anceps* and T_3 cultivar of *F arundinacea* at 60 x 30 cm planting density (Table 2). The yield efficiency values as influenced by clump canopy volume showed non-significant variation in all the three cultivars of *S anceps* at 60 x 30 cm spacing clearly indicating that canopy volume of the clump had non-significant effect on the yield efficiency of all the three genotypes under investigation.

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