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Effect of Different Spatial Arrangements on Forage Yield, Yield Components and Quality of Mott Elephantgrass

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Abstract: The study was conducted to determine the effect of plant spacing on forage yield, yield components and quality of Mott elephantgrass at the Agronomic Research Area of Agronomy (forage production) Ayub Agricultural Research Institute Faisalabad. Mott grass was sown at 45x45 cm, 60x60 cm, 75x75 cm, 90x90 cm 105x105 cm and 120x120 cm spacing (inter row and intra row spacings). Among the different spatial arrangements the first three spacings i.e. 45x45 cm, 60x60 cm and 75x75 cm proved to be more productive, appropriate and acceptable ones. Plant spacing 45x45 cm gave significantly the maximum forage yield t ha^{-1}, fat %, protein content and digestibility against the minimum at 120x120 cm spacing under the agro-ecological conditions of Faisalabad (Pakistan).

Key words: Mott elephantgrass-Spacing-forage yield, yield components quality

Introduction

Continuous supply of adequate and nutritious green forage is essential for the promotion and development of livestock, which plays a significant role in the economy of Pakistan. Livestock sector accounts for 38% of the agricultural value added and about 10% of total G.D.P. (Anonymous, 1997).

Green forage not only meets the fodder requirement but also minimizes the cost of feeding. Though in Pakistan, it is available during most port of the year, yet it is difficult to maintain its regular supply. Due to scarcity of green fodder in May-June and October-November, the animals are subjected to low productivity, which in turn, results in heavy monetary losses to the owners of livestock. Against the estimated requirement of 358.11 million tones, only 165.76 million tones of green forage is available for livestock in Pakistan, which presents 53.71% forage deficiency (Anonymous, 1998).

In Pakistan, about 16 per cent of the total cropped area is put under forage crops annually, even then regular supply of adequate and quality forage is not being ensured (Hanjra ***et al.***, 1995). The present trend to bring more of the cultivated area under cash crops at the expense of forage crops may further deteriorate the green forage supply to livestock.

Shortage of green forage can be alleviated either by shifting growing seasons of the conventional forage crops or by the introduction of high yielding new multicut forages which can supply green herbage in adequate quantities during the scarcity periods (Ahmad ***et al.***, 1993). Recently a number of high yielding forage crop varieties have been introduced in Pakistan and Mott elephantgrass (***Pennisetum purpursum Schum***) is one of the promising forages, which have the potential to meet the challenges, at it not only provides more herbage per unit area but also ensures regular green forages supply due to its multicast nature.

Since the grass is heterozygous and does not breed true from seed, it must be propagated vegetatively to obtain true to type population (Hanna and Monson, 1988), using stem cuttings or root stocks. It is best adopted to moderately well drained soils. Cold tolerance is comparable to that observed for Merkeron, one of the most cold tolerant elephantgrass cultivars.

Mott grass was introduced to Pakistan in 1988. Although some of the farmers have started its cultivation yet its success will depend upon the evolution of a comprehensive package of agro-technology compatible with the local agro-climatic conditions. One vital component of agro-technology for Mott grass is proper plant spacing which play a key role in the development of quick growing grasses like Mott that tillers profusely (Bilal ***et al.***, 2000).

The row spacing chosen may depend on the intended use for the crop stand. Plant spacings of 24 to 30 inches in the row results in a full stand of Mott elephantgrass by early summer of the year after planting (Woodard ***et al.***, 1985). Increasing plant density compensates, at least partially, for stems of low propagation quality (Sollenberger ***et al.***, 1990). Close spacings gives significantly higher forage productivity than wide plant spacing at least during the first year of plant stand establishment of Mott grass (Saeed ***et al.***, 1996).

Materials and Methods

A field experiment was conducted on Mott grass at the Research Area of Agronomy, Forage Production Section, Ayub Agricultural Research Institute, Faisalabad. Soil samples were analysed for physical and chemical properties. A randomized complete block design (RCBD) was used. The experiment was replicated four times. Net plot size was 2.7×13 m, 3.6 m × 13 m, 4.5×13 m, 6.3×13 m and 7.2×13 m for plant spacings S_1= 45×45 cm, S_2= 60 × 60 cm, S_3=75×75 cm, S_4=90×90 cm, S_5=105×105 cm and S_6=120×120 cm, respectively. In each plot there were 6 rows of the crop. Mott elephantgrass was planted manually in the 2nd week of March on a well prepared seed bed as per spacing treatments using root stock of uniform size. The crop was fertilized @ 100 kg N_2 and 100 kg P_2O_5 ha^{-1}. All of the phosphorus and half of N_2 were applied at the time of planting as a basal dose. while the remaining half of N_2 was applied five weeks after planting. Whereas in subsequent two cuttings the full dose of N_2 was applied in two equal splits each at the time of 1st irrigation after cutting and five weeks after the 1st application. All other agronomic practices were kept uniform and normal for all the treatments.

The height of the five randomly selected plants from each plot was measured with a meter and from the base of a plant to its highest growing point at harvest and averaged thereafter. At harvest, number of tillers of five randomly selected and tagged plants in each plot was counted and averaged.

Fresh weight stored was determined by weighing five randomly selected plants from each plot at harvest an a spring balance and averaged. For determining forage yield at harvest, all the plants were cut at an appropriate stubble height and weighed with the help of spring balance. Thereafter the green forage yield per plot (kg) was converted into tones ha^{-1}.

The dried and ground samples were preserved in labeled air tight containers for analysis of various components such as Fat contents, crude protein content and in vitro dry matter digestibility.

The data collected on various parameters were tabulated and subjected to statistical analysis by using Fisher's analysis of variance technique and the treatment means were compared by using least significant difference (LSD) test at 0.05 % level of significance (Steel and Torrie, 1984).

Results and Discussion

Plant height Plant^{-1}

Plant height is an important yield contributing parameter in forage crops. The data in plant height indicated that different spatial arrangements affected the plant height significantly. In three cuttings, the crop planted at 45×45, 60×60 and 75×75 cm although produced at 105×105 and 120×120 cm but were at a par with 90×90 cm spacing pattern. However, the minimum plant height in all the three cuttings were recorded in the planting pattern of 120×120 cm. The more plant height recorded in narrow spacings might partly be attributed to more plants to develop tendency to get increased internodal distance. Similar results were reported by Scurtu (1982) who noted that increasing plant population of maize from 40, 000 to 90, 000 plants ha^{-1} increased plant height from 196 to 215 cm. Nazir ***et al.*** (1997) also reported that plant height of multicut hybrid sorghum decreased progressively with an increase in plant spacing.

Number of tillers stool^{-1} at harvest

Plant density per unit area at harvest is the major yield component in forage crops. It is evident from data that there were significant differences among the spacing patterns in all the three cuttings. In three cuttings, the number of tillers stool^{-1} although increased in a linear fashion with an increase in the size of spacing area from 45x45 cm to 120x120 cm, but the difference between each of 45x45, 60x60, 75x75, 90x90 cm and that of 105x105 cm and 120x120 cm spacing treatments was non-significant. However, the maximum tillers were recorded in a spacing pattern of 120x120 cm followed by 105x105 cm against the minimum of 11.50 tillers stool^{-1}

in a spacing pattern of 45x45 cm. Significant variation among the different spacing patterns was ascribed to their variable nutritional area and ecosystem. In general number of tillers stool^{-1} increased progressively with an increase in the size of spacing. These findings are in agreement with those of Khan and Manghatt (1965) who reported that Bajra Napiergrass produced a greater number of tillers stool^{-1} at wider row spacing. Similar Siddiqui (1994) also reported that number of tillers stool^{-1} in Mott grass increased consistently with an increase in plant spacing.

Fresh weight stool^{-1}

Fresh weight stool^{-1} was affected significantly by different spatial arrangements in all the three cuttings. The crop planted at 120x120 cm produced significantly the highest fresh weight stool^{-1} followed by 105x105 cm spacing which differed significantly from rest of the spacing treatments. The minimum fresh weight stool^{-1} was recorded in the spacing pattern of 45x45 cm which amounted to be 2.44 kg stool^{-1}, respectively against significantly the maximum of 5.17 kg stool^{-1} respectively (Table 1). However, the data in fresh weight stool^{-1} revealed that there was a linear increase in fresh weight stool^{-1} with an increase in spacing size from 45x45 cm to 120x120 cm. Similar results were reported by Patil and Jawala (1977). Who reported that there was a progressive increase in fresh weight plant^{-1} of sorghum (***Sorghum vulgare***) with increase in plant spacing.

Siddiqui (1994) also reported that fresh weight stool^{-1} of Mott grass increased with the increase in plant spacing.

Forage yield (t ha^{-1})

There was a significant variation in forage yield among the different spatial arrangements. The crop planted in the pattern of 45x45 cm yielded significantly higher than all other treatments. There was a consistent decrease in forage yield with an increase in the size of spacing from 45x45 cm to 120x120 cm in all the three cuttings. The total forage yield of 387.0 t ha^{-1} for the three cuttings was recorded at 45x45 cm against the minimum yield of 100.19 t ha^{-1}

Table 1: Ave. Plant height, number of tillers stool^{-1}, fresh weight stool^{-1}, fat contents, protein % and digestibility % in leaves and stem as affected by different spatial arrangements

Treatment spatial arrangement	Plant height (cm)	No. of tillers/ stool	Fresh weight/ stool (kg)	Total forage yield (t ha^{-1}) of (3 cuttings)	Fat contents		Protein%		Digestibility%	
					Leaves	Stem	Leaves	Stem	Leaves	Stem
S_1=45x45 cm	128.9	11.50	2.84	387.50	2.88	1.00	14.90	8.18	72.93	62.49
S_2=60x60 cm	128.1	13.42	3.2	252.91	2.56	0.82	13.80	8.02	72.43	62.64
S_3=75x75 cm	126.9	16.00	3.54	177.54	2.46	0.75	13.15	7.78	72.41	61.95
S_4=90x90 cm	122.0	18.00	3.96	140.75	2.15	0.68	12.55	7.05	72.16	61.63
S_5=105x105 cm	117.2	20.50	4.55	116.23	2.14	0.61	12.13	6.60	71.56	61.29
S_6=120x120 cm	111.5	22.25	5.17	100.19	2.03	0.50	11.50	6.50	71.08	61.16

at 120x120 cm spacing. The highest forage yield at 45x45 cm was attributed to more number of stools unit^{-1} area which ultimately contributed to increased forage yield as compared to wider spacing. These results are in line with those of Khan and Manghatt (1965), Siddiqui (1994) and Saeed ***et al.*** (1996), who reported that green fodder yield of Mott grass decreased as plant spacing was increased. These results further indicated that favorable effect of wider spacing on fresh weight stool^{-1} did not compensate the yield reduction caused by less number of stools at wider spacing.

Fat contents in leaf and stem

Fat content in leaves as well as in stem varied significantly among the different spatial arrangements. The crop planted in the pattern of 45x45 cm being at par with that of 60x60 cm accumulated significantly higher fat content in leaves than at rest of the spacing patterns. The differences among 90x90, 105x105 and 120x120 cm spacing patterns were also non-significant showing a range of 2.03 to 2.15% fat content in leaf (Table 1).

Similarly fat content in stem was recorded significantly the highest in the crop spaced at 45x45 cm which was on a par at 120x120 cm spacing which was at par with that recorded at 105x105 cm or 90x90 cm spacing pattern. Overall, the maximum fat content in plant (leaves & stem) was recorded at narrow spacing of 45x45 cm against the minimum for the crop spaced at 120x120 cm. In general it was observed that the maximum value for ether extract was recorded in leaf fraction and minimum was found in case of stem fraction. These results are in line with those of Gennari and De-Mattos (1977).

Protein content (%)

There was a significant variation among the different spacing treatments with regards to protein content in leaves and stem. Significantly the highest protein content in leaves was recorded in the crop spaced at 45x45 cm against the lowest of 11.50% at 120x120 cm spacing which was at par with that spaced at 105x105 cm or 90x90 cm spacing pattern. Similarly the difference between 75x75 cm and 60x60 cm spacing pattern was non-significant. The higher protein content in leaves at 45x45 cm might be attributed to narrow spacing as a result of which plant absorbed more nitrogen from the soil as compared to wider spacing. It was also due to higher Net assimilation rate at 45x45 cm spacing which resulted in higher protein content.

Similarly protein content in the stem varied significantly among the spacing patterns. Statistically the less protein contents were recorded at 120x120 cm, 105x105 and 90x90 cm spacings with a range of 6.55 to 7.05% which was significantly lower than that recorded at 75x75, 60x60 and 45x45 cm spacing which in turn were at par with one another showing a range of 7.78 to 8.18%. However, the maximum protein content in stem was recorded at 45x45 cm closely followed by 60x60 against the minimum 6.55% at 120x120 cm spacing patterns. These findings are in contrary with those of Singh ***et al.*** (1985) who reported that CP content was the highest (21.0%) in the blue panic grass (***Panicum antidotale***) at the widest row spacing. Gupta ***et al.*** (1976) Gupta and Sagar also reported that leaf has more crude protein than stem.

Digestibility

The digestibility of leaves and stem among the different spacing treatments differed significantly. The crop planted in the pattern of 45x45 cm although had significantly higher digestibility percentage in leaves than rest of the spacing treatments but was on a par with that recorded at 60x60 cm and 75x75 cm spacing patterns which showed the digestibility of 72.41 and 72.43% respectively. The lowest digestibility percentage was recorded at 120x120 cm which was at par with that recorded at 105x105 cm. However, the differences among 90x90, 75x75 and 60x60 cm spacing treatments were non-significant.

Similarly the highest digestibility of stem was recorded at a spacing pattern of 45x45 cm against significantly the lowest at 120x120 cm. The differences between 60x60 cm and 75x75 cm spacing patterns was also non-significant. It was observed that leaf fraction of plant had the highest digestibility whereas it was the lowest in the stem i.e., 61.16%. These results coincide with Sabitti (1985) who reported that mean; ***In vitro*** Dry matter digestibility (IVDMD) was 52% for the whole plant, 56.2% for leaves and 43.3% for stem indigofera.

Wilson ***et al.*** (1989) also reported that IVDMD of buffer grass (***Cenchrus cillaris***) leaves ranged from 64 to 73.4% and that of stems from 47.7 to 61.7%. However, the differences in digestibility was related to morphological and anatomical characteristics of the tissues.

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