Effect of Seed Rate and Row Spacing on Green Fodder Yield of Promising Line of Maize (MS-2010)

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Abstract

A two years field study was conducted to figure out the optimum planting geometry and plant density for a newly developed fodder maize line "MS-2010". Other objective of this study was to investigate the effect of plant density in terms of seed rate and row spacing on various growth parameters and green fodder yield of maize. Three levels of seed rate used were S1 (75 Kg/Ha), S2 (100 Kg/Ha) and S3 (125 Kg/Ha) whereas three levels of row spacing were R1 (15cm), R2 (30cm) and R3 (45cm). It was found that seed rate is more significant in determining the effect of planting density on growth parameters of fodder maize. Plant height and leaf area were significantly affected by seed rate. Green fodder yield was affected both by seed rate and row spacing significantly. Moreover, it was also observed that both the seed rate and row spacing interacted with each other significantly to affect the growth parameters and green fodder yield.

Keywords: Maize; Seed rate; row spacing; Green Fodder Yield; Punjab; Pakistan

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1. Introduction

Range vegetation is continuously decreasing due to ever increasing population, resources abuse, urbanization, industrialization and environmental degradation. This leads to limited animal productivity. Restoration of rangelands and utilization of crop residues is one of the solutions for this problem. Also this deteriorating natural range lands resulted in popularization of the forage crops in the region. The most important forage crops grown in the region are Sorghum, alfalfa and maize. Maize gained considerable popularity among farmer community as fodder crop over the years due to good adaptability, cheap seed, cost effective and its nutritional profile. In Punjab, Maize is cultivated primarily for grain for use as food by milling the grains or boiling the cobs or roasting them before ripening. There is two corps of Maize in this region. The spring season crops extend from February to June whereas duration of summer crop is from July to October. However, the trend of using maize crop for fodder has increased in last years due to increase in number of livestock and increasing demand of animal products by ever rising human population. Kambal (1984) ranked the Maize as one of the best fodder crop due to its high yield and protein contents especially in spring season crop. The maize is now among the major feed source for livestock sector (Rouanet, 1987). Moreover, being high in nonstructural carbohydrates makes Maize an ideal candidate for silage production (Pain, 1978). According to the Food and the Agriculture Organization (2000), the nutrients and high energy of maize crop make it an ideal choice for fodder purpose. Moreover, as Maize has no prussic acid, it can be used as fodder at any stage of the growth (Nour, 1992). Despite of huge potential of Maize as fodder crop, the high demand of maize grain directed the efforts of the agricultural scientists towards increasing its grain yield rather then exploring its potential as quality, high nutrition animal feed. But now its potential as fodder crop is being realized and research is being focused to develop purpose specific varieties of Maize with high green fodder yield and good nutrition. These research efforts are focused both on agronomic and breeding aspects of maize as fodder crop. A new line of fodder maize “MS-2010” has recently been developed which is under different agronomic evaluation studies at this time. When it comes to agronomic aspects, planting density is very important detrimental factor for final yield and nutritional quality of the produce. Plant density is hybrid term of two very important factors. Number one is the Seed rate while the other is the row spacing (Nour, 1992). Planting density, in addition to effecting the fodder yield and quality, also plays major role in economic aspect of fodder production. As the main fodder yield is from vegetative parts, optimum seed rates and row spacing are key factors for producing good yield of nutritional fodder. This study was focused to figure out the optimum plant density of maize as fodder crop and to study the effect of different seed rates and row spacing on growth and yield of maize as fodder crop. Seed rate is the amount of seed sown in unit area. It directly contributes towards plant density and hence green fodder yield. Lucas (1986) suggested comparatively higher seed rate for maize when sowing as fodder crop then for grain crop as increase in seed rate results high plant density and higher fodder yield. Moreover it is reported that fodder yield in Maize is positively correlated to seed rate. (Pinter et al., 1994). Plant density influences the plants competition for light, nutrients moisture which ultimately affects the leaf area index and dry matter yield (Karlen and Camp, 1985; Barrere and Traneau, 1986; Giskin and Efron, 1986). So the seed rate is a direct tool to increase the fodder yield from per unit area. Abu Suwar (1981) added that higher seed rate ensures good plant density by subsidizing the negative effects of low or delayed germination and poor crop stand. Various studies had reported the effect of planting density on plant height; number of leaves per plant and leaf area and green fodder yield. Likewise, Mohammed (1998) had reported increase in plant height, leaf area and green fodder yield due to narrow row spacing. Esechie (1992) reported that higher plant population results in higher dry matter per unit area. Considerably higher fodder yield has been reported in sorghum with higher seed rate (Patel et al. 1967). However opposite results had been reported by Eddowse (1969). These results may be attributed to the adverse effects of lodging and thin stems due to high plant density (Kaliappa, 1974) which also ultimately effect the green fodder yield (Barrere and Traineau, 1986). Overall higher green fodder yield has been reported in maize with increase in plant densities (Schaller and Larson, 1955; Huntter et al., 1970; Graybell et al., 1991 and Roy and Biswas, 1992). Likewise results have also been reported in sorghum where higher plant population by increase in seed rate resulted in higher green fodder yield (Huntter et al., 1970 and Caravertta et al., 1990).

The objective of the present project was to find out the optimum seed rate and row spacing of promising line of maize at which maximum green fodder yield can be obtained.

2. Material and methods

This field experiment was conducted during the 2014-2016 at the Fodder Research Institute, Sargodha. As this trial was repeated for two years, field practices are described only for the first year. Same field and data practices were repeated for the next year. For land preparation, the field was ploughed followed by harrowing leveling and ridging. The experimental area was divided into blocks and plots (experimental units). The experiment was designed into triplicated split plot design. There were two major treatments i.e. Seed rate (S) and Row spacing (R). Seed rate has three levels designated as S1 (75 kg/Ha), S2 (100 Kg/Ha) and S3 (125 Kg/Ha). Likewise, Row spacing also has three effect levels i.e. R1 (15 cm), R2 (30 cm) and R3 (45 cm). Treatments were randomly assigned in each experimental unit. Plot size was kept 1.8 m × 5 m. First irrigation was applied after three weeks of sowing, whereas subsequent irrigations were applied as per field condition. Data was recorded for the following growth parameters.

2.1. Plant height (cm): Plant height was measured from base of the plant to the flag leaf from five randomly selected guarded plants from each experimental unit. The mean plant height was then calculated.

2.2. Number of leaves per plant: Total number of leaves of plant was counted manually of plants selected for measuring plant height. The mean number of leaves was then calculated.

2.3. Leaf area (cm^2): Same selected plants were also used for the measurement of the leaf area. Fourth leaf of each selected plant was used for measurement. Leaf area was calculated by using the formula described by Watson and Watson (1955).

Leaf Area = Length of the leaf × Maximum width of the leaf × 0.75.

2.4.Stem diameter (cm): Same randomly selected plants were used to measure stem diameter from the base of the plant using a measuring tape. The following formula was used;

Circumference = $2\Pi R$

Where, R is half the diameter. So the figure obtained was multiplied by 2 to get the diameter.

2.5. Green Fodder yield (Tons/Ha): Plants were cut at the base from unit area and weighed immediately to obtain fresh green fodder yield. The weight obtained was then converted to the ton per hectare.

2.6. Statistical analysis: Data collected was subjected to the analysis of variance to detect significance of differences among the various treatments and their interactions. (Gomez and Gomez, 1984). Least Significant Difference (LSD) method was used for means separation.

3. Results and Discussion

Analysis of variance revealed the significance of the differences observed for the data collected of various growth parameters (Table 1). It was observed that not only the individual treatments significantly affected the growth parameters important for the fodder yield but these treatments also interacted with each other to considerably affect the growth parameters and yield of the fodder.

Table 1: Analysis for Variance for various growth parameters of Fodder Maize

Source of variation	DF	Plant Height	Stem Diameter	No. of Leaves per Plant	Leaf Area	Green Fodder Yield
Mean Square for Year	1	4722.69**	4.96**	2.32**	3188^{NS}	6.685^{NS}
Mean Square for Seed Rate	2	1070.02**	0.21^{NS}	0.57^{NS}	160179**	288.30**
Mean Square for Row Spacing	2	261.69^{NS}	0.007^{NS}	0.32^{NS}	9637^{NS}	167.18**

Mean square for Row x Seed Interaction	4	102.07^{NS}	0.10^{NS}	0.51^{NS}	55342**	51.85**
Mean Square for Row x Year Interaction	2	7.35^{NS}	0.15^{NS}	0.18^{NS}	13590^{NS}	2.07^{NS}
Mean Square for Seed x Year Interaction	2	943.13**	0.05^{NS}	1.69**	656^{NS}	4.52^{NS}
Mean Square for Row x Seed x Year Interaction	4	194.63^{NS}	0.007^{NS}	0.52^{NS}	3173^{NS}	3.74^{NS}
Mean Square for Error	34	130.47	0.09	0.24	9762	6.07

*Significant at α= 5% level. **Highly Significant at α= 5% level. ^{NS} Non Significant at α= 5% level.

3.1. Plant Height: Despite of the same experimental conditions in both years, average plant height was significantly different in each year. Seed rate has significant effect on the plant height of fodder maize. There was no significant difference observed in plant height with change in row spacing. Likewise seed rate interacted with years to produce significant effect on the plant height (Table 1).

Table 2: Critical mean comparison of treatment and their interactions for their effect on the plant height of fodder maize

Year	Seed Rate	Row Spacing	Year × Seed Rate	Year × Row spacing	Seed Rate × Row Spacing	Row Spacing × Seed Rate × Year
Y2 238.59^{A}	S1 235.28^{A}	R2 233.39^{A}	S1×Y2 252.89^{A}	R2×Y2 242.11^{A}	R2×S2 241.00^{A}	R2×S1×Y2 262.00^{A}
Y1 219.89^{B}	S2 231.89^{A}	R1 228.44^{A}	S2×Y2 238.22^{B}	R1×Y2 238.44^{A}	R2×S1 238.67^{A}	R3×S1×Y2 249.33^{AB}
	S3 220.56^{B}	R3 225.89^{A}	S2×Y1 225.56^{C}	R3×Y2 235.22^{AB}	R1×S1 233.83^{AB}	R1×S1×Y2 247.33^{AB}
			S3×Y2 224.67^{C}	R2×Y1 224.67^{BC}	R3×S1 233.33^{AB}	R2×S2×Y1 241.67^{BC}
			S1×Y1 217.67^{C}	R1×Y1 218.44^{C}	R1×S2 229.50^{ABC}	R2×S2×Y2 240.33^{BCD}
			S3×Y1	R3×Y1	R3×S2	R1×S2×Y2

			216.44^{C}	216.56^{C}	225.17^{BC} R1×S3 222.00^{BC} R2×S3 220.50^{BC} R3×S3 219.17^{C}	240.00^{BCD} R3×S2×Y2 234.33^{BCDE} R1×S3×Y2 228.00^{CDEF} R2×S3×Y2 224.00^{CDEF} R3×S3×Y2 222.00^{DEF} R1×S1×Y1 220.33^{EF} R1×S2×Y1 219.00^{EF} R3×S1×Y1 217.33^{EF} R2×S3×Y1 217.00^{EF} R3×S3×Y1 216.33^{EF} R1×S3×Y1 216.00^{EF} R3×S2×Y1 216.00^{EF} R2×S1×Y1 215.33^{F}
6.31*	7.73*	7.73*	10.94*	10.94*	13.40*	18.95*

***Critical value for the means comparison (LSD value) at α= 5% level.**

No considerable reduction was observed in plant height with increase in seed rate from 75 Kg/Ha to 100 Kg/Ha. However, significant reduction in plant height was noticed at seed rate of 125 Kg/ha. Maximum significantly high plant height was observed during the 1st year at seed rate of 75 Kg/Ha (Table 2).

Row spacing and its interaction with seed rate has no detectable effect on the plant height. It may be concluded that when it comes to effect of the plant density on the plant height of the fodder maize, seed rate is detrimental factor as compared to the row spacing. Reduced row spacing has been found to increase the leaf area index (Olson and Sander, 1988) and increase the plant height (Early et al., 1967 and Scurtu and Raibuh, 1990). This increase in plant height with increase plant density is due to increased competition among plants for light (Evans, 1975). There are some studies which reported that planting density has no significant effect on plant height (Bunting and Willy, 1959; Crossman, 1967). Plant height at maturity was not affected by plant population as reported by Roy and Biswas (1992). These contradicting results may be attributed to the different genetic background of the planting material used, different planting densities used and ultimately different experimental conditions.

3.2. Stem Diameter: Stem diameter was also found significantly different among the two experimental seasons suggesting that it is highly affected by environmental conditions like soil and weather (Table 1). No significant effect of seed rate and row spacing was observed for stem diameter. However, many studies had reported the negative correlation between seed rate and the stem diameter / thickness (Fleming and Wood, 1967 and Rajagopal et al., 1974). Seed rate and row spacing as well as their interaction at different levels failed to significantly affect the stem diameter (Table 3).

Table 3: Critical mean comparison of treatment and their interactions for their effect on the stem diameter of fodder maize

Year	Seed Rate	Row Spacing	Year × Seed Rate	Year × Row spacing	Seed Rate × Row Spacing	Row Spacing × Seed Rate × Year
Y1 2.23A	S1 1.99A	R3 1.95A	S3×Y1 2.36A	R3×Y1 2.33A	R1×S3 2.10A	R3×S3×Y1 2.45A
Y2 1.63B	S3 1.99A	R1 1.93A	S1×Y1 2.28AB	R2×Y1 2.25A	R3×S3 2.04A	R3×S1×Y1 2.40A
	S2 1.81A	R2 1.91A	S2×Y1 2.07B	R1×Y1 2.13A	R3×S1 2.01AB	R1×S3×Y1 2.38A
			S1×Y2 1.71C	R1×Y2 1.73B	R1×S1 2.00AB	R2×S2×Y1 2.25AB
			S3×Y2 1.63C	R2×Y2 1.58B	R2×S1 1.97AB	R2×S3×Y1 2.25AB
			S2×Y2	R3×Y2	R2×S2	R2×S1×Y1

			1.55C	1.58B	1.93AB R2×S3 1.84AB R3×S2 1.81AB R1×S2 1.68B	2.24AB R1×S1×Y1 2.20AB R3×S2×Y1 2.14ABC R1×S3×Y2 1.83BCD R1×S2×Y1 1.82BCD R1×S1×Y2 1.81BCD R2×S1×Y2 1.70CD R3×S1×Y2 1.63D R3×S3×Y2 1.63D R2×S2×Y2 1.61D R1×S2×Y2 1.55D R3×S2×Y2 1.48D R2×S3×Y2 1.43D
0.16*	**0.19***	**0.19***	**0.28***	**0.28***	**0.34***	**0.48***

***Critical value for the means comparison (LSD value) at α= 5% level.**

3.3. Number of Leaves per Plant: Number of leaves per plant is a direct measure of the green fodder yield as well as its nutritional quality. It was observed that number of leaves per plant armed significantly across the years suggesting its sensitivity to experimental conditions beyond field trials control. Although no significant effect was observed by change in seed rate or row spacing on number of leaves per plant but analysis of variance revealed that seed rate do significantly affect the number of leaves per plant through its interaction with years which may be considered environmental condition in this particular case (Table 1).

Table 4: Critical mean comparison of treatment and their interactions for their effect on the number of leaves per plant of fodder maize

Year	Seed Rate	Row Spacing	Year × Seed Rate	Year × Row spacing	Seed Rate × Row Spacing	Row Spacing × Seed Rate × Year
Y1 2.23^{A}	S1 1.99^{A}	R3 1.95^{A}	S3×Y1 2.36^{A}	R3×Y1 2.33^{A}	R1×S3 2.10^{A}	R3×S3×Y1 2.45^{A}
Y2 1.63^{B}	S3 1.99^{A}	R1 1.93^{A}	S1×Y1 2.28^{AB}	R2×Y1 2.25^{A}	R3×S3 2.04^{A}	R3×S1×Y1 2.40^{A}
	S2 1.81^{A}	R2 1.91^{A}	S2×Y1 2.07^{B}	R1×Y1 2.13^{A}	R3×S1 2.01^{AB}	R1×S3×Y1 2.38^{A}
			S1×Y2 1.71^{C}	R1×Y2 1.73^{B}	R1×S1 2.00^{AB}	R2×S2×Y1 2.25^{AB}
			S3×Y2 1.63^{C}	R2×Y2 1.58^{B}	R2×S1 1.97^{AB}	R2×S3×Y1 2.25^{AB}
			S2×Y2 1.55^{C}	R3×Y2 1.58^{B}	R2×S2 1.93^{AB}	R2×S1×Y1 2.24^{AB}
					R2×S3 1.84^{AB}	R1×S1×Y1 2.20^{AB}
					R3×S2 1.81^{AB}	R3×S2×Y1 2.14^{ABC}
					R1×S2 1.68^{B}	R1×S3×Y2 1.83^{BCD}
						R1×S2×Y1 1.82^{BCD}
						R1×S1×Y2 1.81^{BCD}

						R2×S1×Y2 1.70^{CD} R3×S1×Y2 1.63^{D} R3×S3×Y2 1.63^{D} R2×S2×Y2 1.61^{D} R1×S2×Y2 1.55^{D} R3×S2×Y2 1.48^{D} R2×S3×Y2 1.43^{D}
0.26*	0.32*	0.32*	0.46*	0.46*	0.56*	0.80*

***Critical value for the means comparison (LSD value) at α= 5% level.**

Maximum mean number of leaves per plant were observed during 1st year of the experiment at seed rate of 125 Kg/Ha which is statistically at par to seed rate of 75 Kg/ha during the same year. Lowest mean number of leaves per plant was observed during 2nd year of the experiment at seed rate of 100 Kg/Ha (Table 4). Lucas (1986) had reported negative correlation of number of leaves per plant with both attributes of plan density i.e. seed rate and row spacing. In this study, although this negative correlation was observed, but it failed to produce any significant results which may be attributed to significant effect of years. These results also suggest that correlation and effect studies are highly affected by experimental conditions and genetic nature of the planting material.

3.4. Leaf Area: Leaf area directly affects the maize fodder yield and quality because it is the main site of the photosynthesis. Analysis of the variance revealed that leaf area in fodder maize is significantly effected by change in seed rate and hence in planting density. Although, row spacing has no direct significant effect on leaf area, but it significantly affect the leaf area through its indirect effect of interaction with seed rate. Also no significant effect of years was observed for leaf area suggesting the stability of these effect and interactions over the experimental conditions beyond control of field trials (Table 1).

Table 5: Critical mean comparison of treatment and their interactions for their effect on the number of leaf area of fodder maize

Year	Seed Rate	Row Spacing	Year × Seed Rate	Year × Row spacing	Seed Rate × Row Spacing	Row Spacing × Seed Rate × Year
Y1 675.91^{A}	S1 769.63^{A}	R2 694.92^{A}	S1×Y1 779.78^{A}	R2×Y1 731.00^{A}	R2×S1 869.83^{A}	R2×S1×Y1 906.33^{A}
Y2 660.54^{A}	S3 651.97^{B}	R1 655.88^{A}	S1×Y2 759.48^{A}	R1×Y2 674.64^{A}	R1×S1 755.30^{AB}	R2×S1×Y2 833.33^{AB}
	S2 583.07^{C}	R3 653.88^{A}	S3×Y1 652.78^{B}	R3×Y1 659.61^{A}	R3×S3 736.67^{B}	R1×S1×Y2 774.27^{ABC}
			S3×Y2 651.17^{B}	R2×Y2 658.83^{A}	R3×S1 683.75^{B}	R3×S3×Y1 740.00^{BCD}
			S2×Y1 595.17^{B}	R3×Y2 648.14^{A}	R1×S3 656.67^{BC}	R1×S1×Y1 736.33^{BCD}
			S2×Y2 570.98^{B}	R1×Y1 637.11^{A}	R2×S2 652.33^{BC}	R3×S3×Y2 733.33^{BCD}
					R2×S3 562.58^{C}	R1×S3×Y2 706.33^{BCDE}
					R1×S2 555.67^{C}	R3×S1×Y1 696.67^{BCDEF}
					R3×S2 541.22^{C}	R2×S2×Y1 675.33^{BCDEFG}
						R3×S1×Y2 670.83^{BCDEFG}
						R2×S2×Y2 629.33^{CDEFG}
						R2×S3×Y1 611.33^{CDEFG}

						R1×S3×Y1 607.00^{DEFG} R1×S2×Y1 568.00^{EFG} R1×S2×Y2 543.33^{EFG} R3×S2×Y1 542.17^{FG} R3×S2×Y2 540.27^{FG} R2×S3×Y2 513.83^{G}
54.64*	66.93*	66.93*	94.65*	94.65*	115.9*	163.94*

***Critical value for the means comparison (LSD value) at α= 5% level.**

Critical mean comparison for the seed rate indicated that lower the seed rate, higher the leaf area. As lower plant density allows more light penetration and also results in decreased competition for the space and nutrients. Hence seed rate of 75 Kg/Ha produced significantly higher leaf area then other seed rates. Decreased row spacing reduced the leaf area as increased plant population results in increased level of competition and less penetration of the light. Maximum leaf area was observed for the seed rate of 75 Kg/ha with row spacing of 30 cm. significantly lowest leaf area was observed at seed rate of 100 Kg/ha coupled with row spacing of 45 cm (Table 5). Hence it may be inferred that leaf area has direct negative correlation with seed rate and indirect positive correlation with row spacing. Overall, plant density has negative correlation with leaf area of fodder maize. Many studies had reported the effect of seed rate on number of leaves and leaf area. Lucas (1986) had reported the negative correlation between seed rate and the leaf area. Remison and Lucas (1982) found that decreased plant population results in increased leaf area and vice versa. However Moon et al. (1989) reported that seed rate has no significant effect on leaf length and width.

3.6.Green Fodder Yield: The ultimate purpose of using maize as fodder crop is its green fodder yield. All the growth parameters including plant height stem thickness, leaf area and number of leaves per plant ultimately contribute towards final green fodder yield. Analysis of variance revealed significant effect of seed rate, row spacing and their interaction on green fodder yield of the maize. However, these significant effects of seed rate and row spacing remain stable over the years as indicated by non-significant mean sum of squares for the years and their interaction with seed rate and row spacing (Table 1).

Table 6: Critical mean comparison of treatment and their interactions for their effect on the green fodder yield of fodder maize

Year	Seed Rate	Row Spacing	Year × Seed Rate	Year × Row spacing	Seed Rate × Row Spacing	Row Spacing × Seed Rate × Year
Y1 34.25^{A}	S2 37.83^{A}	R2 37.38^{A}	S2×Y2 38.00^{A}	R2×Y1 37.44^{A}	R2×S2 42.33^{A}	R2×S2×Y2 43.00^{A}
Y2 33.55^{A}	S3 34.05^{B}	R1 32.61^{B}	S2×Y1 37.66^{A}	R2×Y2 37.33^{A}	R3×S2 37.83^{B}	R2×S2×Y1 41.66^{AB}
	S1 29.83^{C}	R3 31.72^{B}	S3×Y1 34.44^{B}	R1×Y1 32.88^{B}	R1×S3 35.16^{BC}	R3×S2×Y1 38.66^{BC}
			S3×Y2 33.66^{B}	R3×Y1 32.44^{B}	R2×S3 35.16^{BC}	R3×S2×Y2 37.00^{CD}
			S1×Y1 30.66^{C}	R1×Y2 32.33^{B}	R2×S1 34.66^{CD}	R1×S3×Y1 36.33^{CDE}
			S1×Y2 29.00^{C}	R3×Y2 31.00^{B}	R1×S2 33.33^{CD}	R2×S1×Y1 35.33^{CDEF}
					R3×S3 31.833^{DE}	R2×S3×Y1 35.33^{CDEF}
					R1×S1 29.33^{E}	R2×S3×Y2 35.00^{CDEF}
					R3×S1 25.50^{F}	R1×S2×Y2 34.00^{DEF}
						R1×S3×Y2 34.00^{DEF}
						R2×S1×Y2 34.00^{DEF}
						R1×S2×Y1 32.66^{EFG}

						R3×S3×Y2 32.00^{FG} R3×S3×Y1 31.66^{FG} R1×S1×Y1 29.66^{GH} R1×S1×Y2 29.00^{GH} R3×S1×Y1 27.00^{HI} R3×S1×Y2 24.00^{I}
1.36*	1.66*	1.66*	2.36*	2.36*	2.89*	4.08*

*Critical value for the means comparison (LSD value) at α= 5% level.

It is evident from the results that the green fodder yield of maize is highly dependent upon the seed rate and row spacing as well as their interaction. Hence both the key components of plant density are equally important for final green fodder yield of the maize. Maximum green fodder yield was obtained at seed rate of 100 Kg/Ha whereas 30 cm row spacing gave the best results for green fodder yield of maize. As for as their interaction with each other is concerned, best results for green fodder yield were obtained with seed rate of 100 Kg/Ha at row spacing of 30 cm. The lowest fodder yield was observed with seed rate of 125 Kg/Ha with row spacing of 15 cm. Hence it may be inferred that although green fodder yield increases with increase in plant density but up to a certain point. After that, further dense plantation may have more negative effects on fresh fodder and yield may decline. Increased plant population resulting from narrow row spacing and high seed rate has also been reported to reduce the amount of dry matter produced in the lower leaves of corn canopy (Whigham and Woolly, 1974). However Singh and Singh (1984) concluded that despite of negative effects of high plant density on crop, overall green fodder yield is not effected as poor plant health is compensated by more number of plants per unit area.

In addition to growth attributes, plant density has also been reported to significantly effect the nutritional value of the fodder maize. High planting density through use of high seed rate has been reported to decrease the protein contents of fodder in maize (Nandpuri, 1963) and sorghum (Abu Suwar, 1981; Hago and Mahmoud, 1996). However no significant effect of plant population on crude fiber contents of fodder has been observed (Powell et al., 1991). Based upon these findings it may be hypothesized that per unit area yield of green fodder may be increased by using higher seed rate and narrow row spacing without considerably decreasing the fodder quality of the produce (Graybell et al., 1991).

Conclusion

To determine the ideal planting geometry and plant density for the newly created fodder maize line "MS-2010," a two-year field research was carried out. The investigation of the impact of plant density on several growth parameters and the yield of green fodder from maize was another goal of this study. S1 (75 kg/ha), S2 (100 kg/ha), and S3 (125 kg/ha) were the three levels of seed rate, whilst R1 (15 cm), R2 (30 cm), and R3 were the three levels of row spacing (45cm). It was discovered that seed rate has a greater bearing on how planting density affects the growth characteristics of fodder maize. The seed rate has a big impact on plant height and leaf area. The yield of green fodder was considerably impacted by both seed rate and row spacing. Additionally, it was shown that the seed rate and row spacing had a substantial interaction that affected the growth indicators and green fodder output.

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