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PERFORMANCE OF FODDER MAIZE (*ZEA MAYS* L.) TO DIFFERENT SOWING METHODS AND SEED RATES

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SUMMARY

The field experiment entitled "Performance of fodder maize (*Zea mays* L.) to different sowing methods and seed rates" was conducted at the Research Farm of University College of Agriculture, Guru Kashi University, Talwandi Sabo, Bathinda (Punjab) to study the effect of different sowing methods and seed rates on growth and fodder yield of maize. The trial was laid out in split plot design with three sowing methods (broadcasting, pora and kera) in main plots and three seed rates (20, 30 and 40 kg/ha) in sub plots, replicated four times. Among different methods of sowing, broadcasting was found to be most effective in maize for achieving higher fodder yield. Broadcasting method recorded higher plant height and dry matter accumulation, whereas, kera method resulted in the higher number of leaves/plant and leaf area index of maize. Broadcasting sowing method (412.8 q/ha) recorded the highest fodder yield, which were significantly higher than pora (382.1 q/ha) and kera (371.2 q/ha) methods of sowing. Fodder yield of pora method was statistically at par with kera method. Broadcasting method recorded 8.03 and 11.2% higher fodder yield than pora and kera, respectively, methods of sowing. Maximum fodder yield was obtained with 40 kg/ha seed rate (401.6 q/ha) which was significantly higher than 20 (376.2 q/ha) and 30 kg/ha (388.3 q/ha) seed rates.

Key words : Fodder yield, leaf area index, maize, seed rate, sowing methods

Maize (*Zea mays* L.) belonging to the family Poaceae, popularly known as 'Makki' and is an important *kharif* season cereals as well as fodder crop of North India. It is the third most important cereal food crop next to rice and wheat. In India, the scenario of forage production and utilization presents contrasting picture in comparison to European countries (Bakht *et al.,* 2011). The present fodder resources in the country can meet only 45 to 50% of the requirement and the magnitude off odder deficit vary from state to state. At present, the country faces a net deficit of 62.76% green fodder, 23.46% dry crop residues and 64% feeds as a result crude protein and total digestible nutrients (TDN) deficiency has taken a toll of 28.44 and 24.04% and the trend could well continue in the future (Birthal and Jha, 2005).

There are many constraints for low production and productivity of fodder maize. Maize being highly exhaustive and depletes the soil of its nutrients demands good nutrient management, and poor nutrient management to fodder maize is one of the most important constraints for low productivity. Apart from the good nutrient management, establishment of an optimum plant stand (which influences crop yield and quality through its influence on light interception, rooting pattern and moisture extraction pattern) is equally important to get maximum yield of quality fodder (Reddy and Reddi, 2006). Therefore, for maximum production of fodder per unit area and time, the crop stand should be optimum. Too high or too less number of plants used per unit area of land will cause competition between the plants or derive less potential of plants respectively. So, it is important that there should be optimum number of plants used per unit area of land. Palatability and digestibility are the main criteria for judging the suitability of fodder.

The need of maize as forage increased in the country during the last years due to increase in number of livestock and the high demand for animal products by the increasing human population in the country in general and specifically in big cities. Maize as forage received little attention by researchers in India. Little work has been done regarding plant density, which is an important factor for forage production. Plant density is determined by seed rate as well as by within-row and inter-row spacing. Since the economical yield in forages is mainly from vegetative parts, optimum seed rates for high yield and good quality forage need to be applied. Another practice is the method of sowing

which is an important factor when combined with seed rate because it deals with the arrangement of plant on the ground.

In view of this, the present investigation was made to evaluate the effect of different management options sowing methods along with seed rate on various growth parameters and fodder yield of maize so that suitable adaptation measures can be explored to improve its fodder productivity because of changing climatic conditions.

MATERIALS AND METHODS

A field experiment was conducted during *kharif* season of 2019 at the Research Farm, Department of Agronomy, Guru Kashi University, Talwandi sabo, Bathinda (Punjab). It is situated at 29º33' N latitude and 74º38' E longitude at a height of 208 m above the mean sea level. The experimental site belongs to semi-arid climate, where both summers and winters are acute. A maximum temperature of about 45ºC is common during summer, while freezing temperature accompanied by frost in the months of December and January. The soil of the experimental field was loamy sand in texture which has pH 7.6 with normal electrical conductivity of 0.15 dSm^{-1}. The soil was medium in organic carbon content (0.22%). The available nitrogen (206.0 kg/ha) was low, whereas, the available phosphorus (26.2 kg/ha) was higher and available potassium (150.0 kg/ha) was medium. The site was under mungbean-wheat cropping system for three years before the establishment of the experiment. The field experiments was laid out in split-plot design with 9 treatment combinations consisting of three sowing methods (Broadcasting, pora and kera) in main plots and three seed rates (20, 30 and 40 kg seed/ha) in subplots. Each treatment was replicated four times. The size of the subplots was 2.10 by 5.0 m. Before sowing, the land was prepared well before the sowing the crop with the help of tractor drawn cultivator and disc harrow followed planking to make the seed bed smooth and firm.

Maize variety J 1006 was sown on May 10, 2019 with different methods, as per treatments of sowing using seed rate of 20, 30 and 40 kg/ha, as per treatments. In all the plots, 60 kg nitrogen/ha through urea and DAP and 60 kg P_2O_5 ha through DAP and 30 kg K_2O/ha through MOP were applied at the time of sowing as basal dose. Remaining nitrogen was given in two split doses. First dose @ 40 kg and 65 kg N/ha at 28 DAS (days after sowing) and second dose @ 20 kg and 25 kg N/ha 45 DAS (at silk stage) in 120 and 150 Kg N/ha treatments, respectively, were applied by broadcasting. Pre-emergence application of atrazine @ 1.25 kg *a.i.*/ha was done two days after for the control of weeds. Post sowing irrigations were given to the crop as per crop need. The crop was harvested manually with sickles.

Plant height was recorded at 30 DAS, 45 DAS and at harvest, from ten randomly tagged plants in central rows (outer rows not included) of each experimental plot. Plant height was measured from ground level to the base of fully opened leaf. The number of leaves per plant of the plants selected for recording plant height was recorded and average values were worked out. Leaf area index (LAI) was calculated by using the following formula-

$$LAI = \frac{\text{Leaf area/plant } (cm^2)}{\text{Ground area/plant } (cm^2)}$$

The crop from each net plot (leaving border and penultimate rows) was harvested and immediately weighed in kg/plot and then converted into q/ha.

Analysis of variance was performed using Proc GLM procedure of SAS version 9.4 (SAS. 2017) and significant mean differences were tested using Fisher's protected least significant difference (LSD) test at $\alpha = 0.05$.

RESULTS AND DISCUSSION

Effect on maize growth

Plant height

The data (Table 1) pertaining to effect of different sowing methods and seed rates on maize plant height revealed broadcasting method of sowing recorded the highest plant height, which was significantly higher than kera method, but it was statistically at par with pora method of sowing at 30 and 45 days after sowing (DAS). At fodder cutting, broadcasting method of sowing recorded the highest plant height, which was significantly higher than kera and pora methods of sowing. Kera method recorded the lowest plant height at all stages.

Among seed rates, at 30 and 45 DAS, the highest plant height was obtained with 40 kg/ha seed rate which was significantly higher than 20 and 30 kg/ha seed rates (Table 1). Seed rate @ 40 kg ha^{-1} results in the maximum plant height, which was significantly higher than 20 kg ha^{-1} seed rates and being

TABLE 1
Plant height and number of leaves per plant of fodder maize as influenced by different sowing methods and seed rates

Treatments	Plant height (cm)			Number of leaves/ plant		
	30 DAS	45 DAS	At harvest	30 DAS	45 DAS	At harvest
Sowing methods						
Broadcasting	85.6	146.2	219.5	5.44	8.22	13.3
Pora	84.0	141.9	214.0	5.22	8.00	13.2
Kera	77.4	137.8	210.3	5.89	8.89	13.8
LSD (P=0.05)	2.3	4.8	2.4	0.12	0.21	0.03
Seed rate (kg/ha)						
20	73.1	132.8	211.0	5.67	8.56	14.0
30	82.2	143.0	215.8	5.55	8.44	13.2
40	91.7	150.2	217.0	5.34	8.11	13.1
LSD (P=0.05)	4.8	5.3	3.3	0.09	0.10	0.02

at par with 30 kg/ha at harvest. Increase in plant height with higher seed rates may be due to competition for light. Further, auxins have basipetal movement and shading effect causes the auxins to move from illuminated side to shade side and thus the imbalance of auxin causes more elongation of plants in shade. Since auxin is sensitive to light, shading prevents its destruction and thus higher accumulation of auxin in shady plants triggers its growth to height. Similar results were also reported by Begum *et al.* (2018).

Number of leaves/plant

Kera method of sowing recorded the highest number of leaves/plant, which was significantly higher than broadcasting and kera methods of sowing at 30, 45 DAS and at harvest (Table 1). Broadcasting method resulted in the lowest number of leaves/plant. The effect of seed rate on number of leaves/plant was significant at 30, 45 DAS and at harvest. At 30 and 45 DAS and at harvest, the highest number of leaves/ plant was recorded with 20 kg/ha seed rate which was significantly higher than 30 and 40 kg/ha seed rates. Decrease in number of leaves/plant with higher seed rates may be due to competition for light. Similar results were also reported by Gul *et al.* (2015) and Memon *et al.* (2007).

Leaf area index

Kera method of sowing recorded the highest leaf area index, which was significantly higher than broadcasting and pora methods of sowing at 30 and 45 DAS and at harvest (Table 2). Broadcasting method recorded the lowest leaf area index at all stages. The perusal of data on periodic leaf area index showed significant and consistent improvement with an increase in seed rate from 20 to 40 kg/ha. Seed rate @ kg/ha recorded the highest leaf area index, which was significantly higher than other seed rates. It might be due to the effect of high plant population on vegetative and reproductive development. Similar findings have been reported by Valadabadi and Farahani (2010).

TABLE 2
Leaf area index and dry matter accumulation of fodder maize as influenced by different sowing methods and seed rates

Treatments	Leaf area index			Dry matter accumulation (q/ha)	
	30 DAS	45 DAS	At harvest	30 DAS	45 DAS
Sowing methods					
Broadcasting	2.36	4.00	4.58	37.5	83.6
Pora	2.42	4.05	5.90	37.3	83.3
Kera	2.46	4.10	6.55	35.8	74.4
LSD (P=0.05)	0.03	0.04	0.22	0.2	0.8
Seed rate (kg/ha)					
20	2.29	3.96	5.57	36.2	75.5
30	2.39	4.04	5.67	36.3	80.7
40	2.55	4.16	5.79	38.2	85.1
LSD (P=0.05)	0.08	0.02	0.30	0.4	1.3

Dry matter accumulation

The effect of sowing methods on dry matter accumulation was significant at 30 and 45 DAS. Broadcasting method of sowing recorded the highest dry matter accumulation, which was significantly higher than kera method, but it was statistically at par with pora method of sowing at 30 and 45 DAS. Kera method recorded the lowest dry matter accumulation at all stages. The data revealed that dry matter accumulation of maize varied significantly due to different seed rate. Maximum dry matter accumulation was obtained with 40 kg/ha seed rate which was significantly higher than 20 and 30 kg/ha seed rates. The result suggests that higher seed rate produced maximum dry matter accumulation. Therefore, seed @ 40 kg/ha seems optimum which could be due to the most desirable population or planting density in the existing environmental conditions in the region. This might be due to the inter plant competition for moisture, nutrient, light and space availability by virtue of which performance of single plant was diminished. In the light of literature reviewed, present findings are in conformity with the findings obtained by most of the researchers for various legumes and oil seeds (Imtiaz *et al.*, 1988).

Effect on maize fodder yield

Total green fodder production per unit area is the most important aspect of fodder crops and is one of the criteria to assess the efficiency of various treatments. Sowing methods significantly influenced the fodder yield of maize (Table 3). Among the sowing

method treatments, broadcasting significantly increased the fodder yield. Broadcasting sowing method (412.8 q/ha) recorded the highest fodder yield, which were significantly higher than pora (382.1 q/ha) and kera (371.2 q/ha) methods of sowing. Fodder yield of pora method was statistically at par with kera method. Broadcasting method recorded 8.03 and 11.2% higher fodder yield than pora and kera, respectively, methods of sowing. With a dense canopy, erect leaves can facilitate sunlight penetration to the bottom leaves which thereby enhance photosynthesis; conversely, the shading of horizontal leaves leads to the premature senescence of the bottom leaves and a reduction in photosynthetic activity (Borojevic *et al.,* 1980).

Further, perusal of the data revealed that fodder yield of maize varied significantly due to different seed rate. Maximum fodder yield was obtained with 40 kg/ha seed rate (401.6 q/ha) which was significantly higher than 20 (376.2 q/ha) and 30 kg/ha (388.3 q/ha) seed rates. The result suggests that higher seed rate produced maximum fodder yield. Therefore, seed @ 40 kg/ha seems optimum which could be due to the most desirable population or planting density in the existing environmental conditions in the region. This might be due to the inter plant competition for moisture, nutrient, light and space availability by virtue of which performance of single plant was diminished. In the light of literature reviewed, present findings are in conformity with the findings obtained by most of the researchers for various legumes and oil seeds (Maqsood *et al.,* 2001; Biswas *et al.,* 2002; Ashraf *et al*., 2003; Hayat *et al*., 2008).

TABLE 3
Fodder yield of maize as influenced by different sowing methods and seed rates

Sowing methods	Fodder yield (q/ha) Seed rate (kg/ha)			Mean
	20	30	40	
Broadcasting	395.2	412.5	430.8	412.8
Pora	370.8	382.3	393.1	382.1
Kera	362.5	370.1	380.9	371.2
Mean	376.2	388.3	401.6	388.7
LSD (P=0.05)	Sowing methods (M): 13.4		Seed rate (S): NS	
	Interaction (S×F) : NS			

CONCLUSIONS

It may be concluded that broadcasting was found to be most effective in maize for achieving higher fodder yield. Broadcasting sowing method (412.8 q/ha) recorded the highest fodder yield, which was significantly higher than pora (382.1 q/ha) and *kera* (371.2 q/ha) methods of sowing. Fodder yield of pora method was statistically at par with kera method. Broadcasting method recorded 8.03 and 11.2% higher fodder yield than pora and kera, respectively, methods of sowing. Maximum fodder yield was obtained with 40 kg/ha seed rate (401.6 q/ha) which was significantly higher than 20 (376.2 q/ha) and 30 kg/ha (388.3 q/ha) seed rates.

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