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Fodder yield, economics and quality of "Pratap Makka Chari-6" (*Zea mays* L.) under varying plant densities and fertility levels

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Abstract

A field experiment entitled "Fodder Yield, Economics and Quality of Fodder maize "Pratap Makka Chari-6" (*Zea mays* L.) Under Varying Plant Densities and Fertility Levels" was conducted at Instructional Farm, Rajasthan College of Agriculture, Udaipur during *kharif* 2015 and 2016 with objective to evaluate production potential of fodder maize under varying plant densities and fertility levels. The treatment consisted combinations of four plant densities (1,33,333, 1,66,666, 2,22,222 and 3,33,333 plants ha^{-1}) and four fertility levels (90 + 30, 110 + 40, 130 + 50 and 150 + 60 kg N + P_2O_5 ha^{-1}). The plant density of 2,22,222 plants ha^{-1} recorded significantly higher green and dry fodder yield, net return and B C ratio over 1,66,666 and 1,33,333 plants ha^{-1} and proved economically profitable compared to rest of the densities. Increasing plant density from 1,33,333 to 3,33,333 plants ha^{-1} decreased crude protein content significantly, however, failed to influence other quality parameters significantly. N and P content decrease with increasing plant densities, However, K content was at par with increasing plant densities. N, P and K content decrease with increase in plant density. However, K content was at par with increasing plant densities. N, P and K uptake increased significantly with increasing plant density. The green fodder yield, net return and B C ratio recorded under application of 130 kg N + 50 kg P_2O_5 ha^{-1} were significantly higher over 110 kg N + 40 kg P_2O_5 and 90 kg N + 30 kg P_2O_5 ha^{-1} and proved economically beneficial. Application of 130 kg N + 50 kg P_2O_5 ha^{-1} also improve nutrient content their uptake and sustain quality of fodder maize.

Keywords: Yield, economics and quality of fodder maize

Introduction

The demand of animal product such as milk, eggs and the meat are increasing day by day with increasing plant population in India.The increase in demand for livestock products has given impetus to greater livestock population within the existing farming system and also emphasizing the need of feed and fodder security in country. At present, the country faces a net deficit of 61.1 per cent green fodder, 21.9 per cent of dry crop residue and 64 per cent feeds (Chaudhary *et al.*, 2012) [2]. Thus fulfilling the demand for feed and fodder will be major challenge for the livestock sector of the country. Maize (*Zea mays* L.) is most ideal and suitable crop for fodder as well as silage because of its high yielding ability, excellent nutritional profile, its quick growing nature, succulence, palatability and excellent quality without any anti-nutritional factor, when harvested at any stage of crop growth (Kumar *et al.*, 2018) [3]. The climate of the southern Rajasthan is very favourable for maize crop. In this zone it is mainly grown as rainfed crop during monsoon season. In recent past development of composite fodder maize "Pratap Makka Chari-6" has opened a new avenue for exploiting higher green fodder for livestock. Thus identification and development of production technology *i.e.* plant density and fertility level for fodder maize "Pratap Makka Chari-6" as per crop growing situation is considered to be the first and foremost step for enhancing its green fodder production.

Materials and Methods

The field experiment was carried out during *kharif* 2015 and 2016 at the Instructional Farm, Rajasthan College of Agriculture, Udaipur, Rajasthan which is situated at 23°34'N latitude and 73°42'E longitude at an altitude of 582.17 meter above the mean sea level.

The soil of the experiment site was clay loam having pH 7.2 & 7.3, organic carbon 0.65 & 0.67, available nitrogen 278.1& 272.3 kg ha^{-1}, phosphorus 18.1 & 18.4 kg ha^{-1} and potassium 302.3 & 301.5 kg ha^{-1} in the plough layer. The well distributed rainfall of 474.1 & 664.3 mm was recorded during crop growth period, respectively. The treatment consisted combinations of four plant densities (30 x 25cm = 1,33,333, 30 x 20 cm = 1,66,666, 30 x 15 cm = 2,22,222 and 30 x 10 cm = 3,33,333 plants ha^{-1}) and four fertility levels (90 + 30, 110 + 40, 130 + 50 and 150 + 60 kg N + P_2O_5 ha^{-1}). These sixteen treatment combinations were evaluated under factorial randomized block design with three replications during both the years. Fodder maize variety 'Pratap Makka Chari-6" release by MPUAT, Udaipur was used as test variety. During both the years the crop was sown manually on first week of July placing seeds at a depth of 4-5 cm maintaining rows and plants spacing as per treatment. The experimental plot size was 15 m^2. The green crop was harvested at 100 per cent tasseling stage. Phosphorus as per treatments was applied as basal, whereas nitrogen was applied in 3 equal splits *viz.*, 1/3 as basal, 1/3 at knee high stage and remaining 1/3 at initiation of tassel. In order to minimize weed competition, pre-emergence application of atrazine at 0.5 kg ha^{-1} followed by one hoeing and earthing up at 20 days after sowing was carried out. Net returns B C ratio was calculated on basis of prevailing market prices of inputs and green fodder rate. LAI, chlorophyll, protein content, nutrient content and uptake other quality parameters were worked out by using standard methods of analysis and formula. Data of each character collected were statistically analyzed using standard procedure of variance analysis.

Results and Discussion

Plant densities

The pooled basis results of the experiment revealed that the plant height recorded under 2,22,222 plants ha^{-1} was significantly higher over 1,66,666 and 1,33,333 plants ha^{-1}. Further increase in plant density from 2,22,222 to 3,33,333 plants ha^{-1} failed to record significant variation in plant height at harvest. Increase in plant height seems to be the resultant of mutual shading due to overcrowding of plants which force plants to grow with faster rate (Parik *et al.*, 2019) [5]. Shivalakshmi *et al.*, (2012) [8] described this as a "cooperative movement" wherein smaller plants tend to catch-up with taller plants by means of it and compete more on even terms and conditions. The maximum LAI was recorded under 3,33,333 plants ha^{-1} which was significantly higher over rest of the plant densities. The increase in LAI with increasing plant densities was in close accordance with findings of Bhatt, (2012) [1]. Days taken to 50 per cent tasseling and chlorophyll content did not vary significantly under increasing plant densities from 1,33,333 to 3,33,333 plants ha^{-1}. However, maximum dry matter $plant^{-1}$ stem girth and diameter was recorded under 1,33,333 plants ha^{-1} and increasing plant densities decrease these growth parameters to varying extents. Further the results of experiment revealed that green fodder, dry fodder yield, net return and BC ratio were recorded under 2,22,222 plants ha^{-1} which were significantly higher over 1,66,666 and 1,33,333 plants ha^{-1}. Advancing plant densities from 2,22,222 to 3,33,333 plants ha^{-1} failed to record statistical significance in green fodder, dry fodder yield, net return and BC ratio. Despite decrease in stem girth, width and dry matter with increasing plant density, the recorded significant improvement in green fodder yield and dry fodder yield was on account of higher number of plants per unit area under increasing density. These results are in line with the results reported by Shanti *et al.* (2014) [7], Sandya *et al*. (2016) [6]. Potassium content of fodder maize was statically at par under increasing plant densities. Maximum nitrogen and phosphorus content was recorded under density of 1,33,3333 plant ha^{-1} which was significantly higher over rest of the plant densities. Maximum nitrogen, phosphorus and potassium uptake by stover of maize was recorded under plant density of 2,22,222 plants ha^{-1} which was significantly higher over plant density of 1,33,333 plants ha^{-1}, however, proves statistically at par with uptake recorded under 1,66,666 plants ha^{-1}. Increasing plant densities failed to record perceptible variation in quality parameters *viz.*, crude fibre content, ether extracts content, nitrogen free extract, total digestive nutrients, total soluble solids, mineral and ash content. Whereas increasing plant densities significantly decreased crude protein content.

Fertility levels

Increasing fertility level significantly increased plant height, dry matter accumulation, LAI, chlorophyll content, stem girth and stem diameter at varying extents. Increasing fertility level significantly reduced days taken to 50 per cent tasseling. Application of 130 kg N + 50 kg P_2O_5 ha^{-1} significantly increased green fodder, dry fodder yield net return and BC ratio over 110 kg N + 40 kg P_2O_5 ha^{-1} and 90 kg N + 30 kg P_2O_5 ha^{-1}. At the same time further increase in fertility level failed to record statistical significance. The nitrogen, phosphorus and potassium content of fodder maize increased at varying extent under increasing fertility level from 90 kg N + 30 kg P_2O_5 ha^{-1} to 150 kg N + 60 kg P_2O_5 ha^{-1}.

Increasing fertility level from 90 kg N + 30 kg P_2O_5 ha^{-1} to 110 kg N + 40 kg P_2O_5 ha^{-1} and 110 kg N + 40 kg P_2O_5 ha^{-1} to 130 kg N + 50 kg P_2O_5 ha^{-1} significantly enhanced nitrogen, phosphorus and potassium uptake. At the same time further increase in fertility level from 130 kg N + 50 kg P_2O_5 ha^{-1} to 150 kg N + 60 kg P_2O_5 ha^{-1} failed to record perceptible variation in this respect. Minimum crude protein content, crude fibre content, ether extract content and mineral ash content were recorded under application of 90 kg N + 30 kg P_2O_5 ha^{-1}. Increase in fertility level from 90 kg N + 30 kg P_2O_5 to150 kg N + 60 kg P_2O_5 ha^{-1} increased these quality parameters at varying extent.

At the same time increase in fertility level decrease TDN and TSS content at varying extent. Increasing fertility level enriched soil with N, P and K to the level of sufficiency which suggests greater availability of metabolites and nutrients and thus reduce competition of these between developing structure consequently improving functional activities of each vegetative structure and caused vigorous growth of individual plant and also caused significant variation in different quality parameters (Suthar *et al*., 2013) [9] and (Meena *et al*., 2017) [4].

Table 1: Effect of plant densities and fertility levels on growth yield and economics of fodder maize cultivation

Treatments	Stem Girth (cm)	Stem Diameter (cm)	Plant Height (cm)	Dry matter plant^{-1} (g)	LAI	Days to 50% tasseling	Chlorophyll (mg g^{-1})	Yield (q ha^{-1}) Green fodder	Yield (q ha^{-1}) Dry fodder	Economics ha^{-1} Net returns	Economics ha^{-1} B C Ratio
Plant densities											
1,33,333 plants ha^{-1}	1.63	5.11	276.04	84.62	9.55	45.96	2.30	334.82	83.71	82419	4.57
1,66,666 plants ha^{-1}	1.55	4.88	287.73	68.74	11.36	46.50	2.31	351.70	87.92	87331	4.80
2,22,222 plants ha^{-1}	1.51	4.73	303.21	56.54	15.86	46.21	2.32	376.37	94.09	94584	5.15
3,33,333 plants ha^{-1}	1.43	4.48	312.51	41.51	17.41	46.42	2.32	378.77	94.69	95154	5.14
S.Em.±	0.02	0.06	2.96	0.55	0.09	0.36	0.01	3.42	0.86	1027	0.06
C.D.(P=0.05)	0.06	0.18	8.38	1.55	0.26	NS	NS	9.68	2.42	2905	0.16
Fertility levels (N + P_2O_5 kg ha^{-1})											
090+ 30	1.45	4.56	276.28	55.89	13.10	47.8	2.26	328.28	82.07	80825	4.58
110 + 40	1.52	4.78	295.09	61.98	13.53	46.6	2.33	349.56	87.39	86813	4.81
130 + 50	1.59	4.98	301.87	66.23	13.73	46.2	2.33	379.07	94.77	95269	5.16
150 + 60	1.56	4.88	306.26	67.31	13.83	44.5	2.34	384.76	96.19	96580	5.12
S.Em.±	0.02	0.06	2.96	0.55	0.09	0.4	0.01	3.42	0.86	1027	0.06
C.D.(P=0.05)	0.06	0.18	8.38	1.55	0.26	1.0	0.02	9.68	2.42	2905	0.16

Table 2: Effect of plant densities and fertility levels on nutrient content, uptake and quality of fodder

Treatment	Nutrient content (5)			Nutrient uptake (kg ha^{-1})			Quality of fodder						
	Nitrogen	Phosphorus	Potassium	Nitrogen	Phosphorus	Potassium	CPC	CFC	EEC	NFE	TDN	TSS	MA
Plant densities													
1,33,333 plants ha^{-1}	0.909	0.234	1.128	76.28	19.76	94.69	5.68	25.10	2.65	59.46	96.20	3.74	7.11
1,66,666 plants ha^{-1}	0.901	0.226	1.125	79.42	20.04	99.20	5.63	25.33	2.67	59.20	96.17	3.75	7.17
2,22,222 plants ha^{-1}	0.896	0.221	1.119	84.48	20.92	105.57	5.60	25.53	2.69	58.96	96.14	3.75	7.22
3,33,333 plants ha^{-1}	0.886	0.211	1.109	84.03	20.09	105.28	5.54	25.43	2.68	59.16	96.16	3.76	7.19
S.Em.±	0.005	0.001	0.005	0.92	0.24	1.05	0.03	0.16	0.02	0.22	0.02	0.03	0.04
C.D.(P=0.05)	0.014	0.003	NS	2.60	0.70	2.97	0.09	NS	NS	NS	NS	NS	NS
Fertility levels (N + P_2O_5 kg ha^{-1})													
090+ 30	0.830	0.180	1.041	68.14	14.75	85.47	5.19	23.11	2.43	62.69	96.61	4.19	6.58
110 + 40	0.915	0.225	1.121	79.90	19.68	97.98	5.72	24.09	2.54	60.82	96.43	3.83	6.84
130 + 50	0.920	0.242	1.159	87.14	22.91	109.75	5.75	26.88	2.84	56.95	95.96	3.61	7.58
150 + 60	0.926	0.244	1.160	89.02	23.47	111.54	5.79	27.31	2.88	56.32	95.51	3.37	7.69
S.Em.±	0.005	0.001	0.005	0.92	0.24	1.05	0.03	0.16	0.02	0.22	0.02	0.03	0.04
C.D.(P=0.05)	0.014	0.003	0.015	2.60	0.70	2.97	0.09	0.45	0.05	0.61	0.06	0.07	0.12

CPC: Crude protein content, CFC: Crude fibre content EEC: Ether extracts content, NFE: Nitrogen free extract, TDN: Total digestive nutrient, TDN: Total soluble solid and MA: Mineral ash

Conclusion

It is inferred that maintaining 2,22,222 plants ha^{-1} by planting maize at 30 x 15 cm apart and application 130 kg N + 50 kg P_2O_5 ha^{-1} produced significantly higher green fodder yield, sustain quality of fodder and also proved economically beneficial with highest net returns and BC ratio.

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