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Influence of Spacing and Graded Levels of NPK on Yield and Protein Content of Quality Protein Maize (Zea mays L.)

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Abstract: ***A field experiment was conducted during Kharif 2010 under irrigated condition on red sandy loam soil to study the influence of spacing and graded levels of NPK on yield and protein content of Quality Protein Maizeat Zonal Agricultural Research Station, Visweshwaraiah Canal Farm, Mandya. The result indicated that, the maize yield was higher in closer spacing of 45 cm × 30 cm (4921 kg ha^{-1}) compared to wider spacing of 60 cm × 30 cm (4556 kg ha^{-1}). Among different nutrient levels 125 % RDN recorded significantly higher grain yield (5143 kg ha^{-1})it was on par with 100 % RDN (4829 kg ha^{-1}) and 150 % RDN (5087.93 kg).Whereas75 % RDN recorded lower grain yield (3893.49 kg). Significantly higher B:C ratio was recorded with nutrient level of 125% RDN (2.12)which was on par with 100% RDN (2.11) and 150% RDN (1.93).Whereas 75 % RDN recorded lowerB:C ratio (1.85).Significantly higher netreturn (Rs. 40086 ha^{-1}) was recorded with T_3(45 x 30 cm +125 % RDN)treatment,followed by T_4(45 cm x 30 cm + 150% RDN) Rs.38770 ha^{-1}and T_2 (45 cm x 30 cm + 100 % RDN) Rs. 37305 ha^{-1}. Significantly lower net return was recorded with T_5(60 x 30 cm + 75% RDN) treatment,Rs. (25163).With increase in nutrient dose from 100 % RDN to 125 % RDN, the grainyield was increased by seven per cent. The highest protein content was recorded with 125 % RDN (11.24 %) which was on par with 150 % RDN (11.09 %).Protein content increased up to nine per cent.Significantly lower protein content was recorded with 75 % RDN (9.91 %).The interaction of 125 % RDN along with wider spacing of 60 cm x 30 cm recorded the highest mineral content (1.53 g) in grain.***

1. Introduction

Maize (Zea mays L.)Is one of the most important cereal crop of the world as well as India.In India, maize is grown in an area of 8.12 m ha with an annual production of about 19.77 m t. The average productivity of maize in India is about 2400 kg ha^{-1}. In India, the area under maize is mainly concentrated in Uttar Pradesh, Rajasthan, Madhya Pradesh, Bihar, Gujarat, Karnataka and Himachal Pradesh states and it is also grown in small areas in almost all the states. In Karnataka, Maize occupies an area of 1.20 m ha, Production of 3.20 m t with productivity of 2849 kg ha^{-1} (Anon, 2009). The varieties recommended for state are low in protein content with unbalanced composition of amino acids viz. low lysine and tryptophan and high leucinecontent, thus cause protein deficiency and mal-nutrition in poor class people who have maize as principle dietary source. To overcome this problem, quality protein maize was developed with high protein content and essential amino acids. Hence, there is need to test this variety for enhancing productivity and providing balanced dietary source to poor tribal people of the area.The lower productivity of maize is attributed to the lack of site specific production package and physiological limitations. Among the various constraints responsible for low seed yield and quality are inadequate and lack of balanced nutrition, couple with optimum spacing, plays a major role. Nitrogen plays a significant role in growth, as it is a component of chlorophyll and protein. It favorably influences the growth parameters like plant height, leaf area, leaf duration, dry mater production and finally the yield. While phosphorus being a component of ATP and ADP, acts as energy currency providing the energy required during photosynthesis and carbon assimilation. Potassium favors proper grain filling apart from its role in water retention potential. Keeping the above in view the investigation on quality protein maize was undertaken.

2. Material and Methods

The experiment was conducted during *Kharif* 2010 under irrigated condition on red sandy loam soil to study the Influence of spacing and graded levels of NPK on yield and protein content of Quality Protein Maizeat Zonal Agricultural Research Station, Visweshwaraiah Canal Farm, Mandya. The soil was sandy loam, slightly acidic in reaction (PH 6.5), medium in available N (359.78 kg ha^{-1}), available K (178.27 kg ha^{-1}) and high in available P (49.2 kg ha^{-1}). The experiment consisted of twospacing viz.,45 cm x 30 cm and 60 cm x 30 cm and four nutrient levels viz. 75, 100, 125 and 150 % ofrecommended dose of nutrients (RDN). Fifty per cent of recommended N and entire recommended P & K was applied as basal dose at the time of sowing as per treatment, and the remaining 50 per cent of the nitrogen was applied at 30 DAS as top dress. The QPM hybrid "Shaktiman-4" was used as test crop. In order to control weeds, Hand weeding was done twice at 15 and 30 days after sowing and two times inter cultivation by passing hoe was carried out at 30 and 45 days after sowing to keep all the plots weed free throughout the crop growth period. The crop was sown at 28-05-2010 and harvested in 22-09-2010.

3. Results and Discussion

Significantly higher number of cob per plant, number of grains per cob and grain weight per cobwas recorded with 100 % RDN (Table 1). Further increase in nutrient levels though improved these characters but failed to record statistical significance. However, cob length, number of row per cob and number of cob per plant responded significantly up to 125 % RDN.Significantly higher number of cob plant^{-1} (1.13) is recorded in cropping geometry of 60 cm x 30 cm compared to 45 cm x 30 cm (1.10) and higher cob weight and number of rows per cob is also recorded higher(179.52 g) and (15.05)in spacing 60 cm x 30 cm as compared to 45

cm x 30 cm spacing (171.45 g) and (14.55)respectively (Table 1)

Application of 100 % RDN improved the grain yield (4829 kg ha^{-1}) and stover yield (7741 kg ha^{-1}) over 75 % RDN (3893 kg ha^{-1} and 7093 kg ha^{-1}) respectively. Further increase in nutrient levels up to 125 %RDNincreased both grain yield and stover yield (5143 kg ha^{-1} and 7778 kg ha^{-1}) which is on par with 150% RDN but statistically not significant (Table 2).Yadav and Singh (2000)reported that yield of maize was enhanced with higher nitrogen levels. Net returns declined when nutrient level was reduced to 75 % RDN (Rs. 26619). Contrarily, significant increase was obtained by advancing the rate of nutrient from RDN (Rs. 35349) to 125 % RDN (Rs. 37549) which is on par with 150 % RDN (Rs. 36075). Highest B:C ratio was recorded under 125 % RDN which was at par with 100 % and 150 % RDN but significantly higher than 75 % RDN. The results are in accordance with findings of Singh and Yadav (2007).

Sowing at 45 cmx 30 cm spacing recorded highest maize seed yield (4921.26 kg ha^{-1}) compared to wider spacing of 60 cm x 30 cm (4555 kg ha^{-1}). These results are in conformity with the findings of Fanadzo*et al.*2010.Significantly higher B:C ratio was recorded with closer spacing of 45 cm x 30 cm along with 125 % RDN (2.29) which was on par with 100 % RDN and 150 % RDN (2.25 and 2.10) respectively. Significantly lower B:C ratio was recorded in spacing 60 cm x 30 cm with 75 % RDN (1.76) followed by 45 cm x 30 cm with 75 % RDN (1.79).

Significantly higher protein content (10.72 %) was recorded with 60 cm x 30 cm spacing. whereas 45 cm x 30 cm recorded lower protein content (10.55 %). This study is in line with the results of Zuber*et al.* 1954.Significantly higher protein content recordedwith 125% RDN (11.24 %) which was on par with 150% RDN (11.09 %).Lower protein content was recorded with 100% RDN (10.28 %) and 75% RDN (9.91 %).This result is in line with findings of Singh and Yadav (2007). The total ash (minerals) content in grain was significantly higher with spacing of 60 cm x 30 cm (1.497 g) than spacing of 45 cm x 30 cm (1.465 g).Significantly higher ash content (1.50 g) was recorded withnutrient level of 125 % and 150 % RDN which was on par with 100 % RDN (1.47 g).Lower ash content was recorded with 75% RDN (1.45 g). Interaction effect revealed that 125 % RDN with wider spacing of 60 cm x 30 cm recorded the highest (1.53 g) mineral content in grain.

The present study indicated that the application of 125per cent ofRDN(188 : 94 : 50 N, P_2O_5 and K_2O kg ha^{-1}) along with row spacing of 45 cm x 30 cm is helpful in obtaining maximum seed yield (5361 kg ha^{-1}), highest B:C ratio (2.29) and high protein content (10.99 %)in QPM hybrid (Shaktiman-4).

Table 1: Influence of spacing and graded level of NPK on yield parameters of Quality Protein Maize

Treatment	Cob length (cm)	Number of grains cob^{-1}	Grain weight cob^{-1}(g)	100 grain weight (g)	Number of cob $plant^{-1}$	Number of rows cob^{-1}
Spacing						
45 cm × 30cm(S_1)	14.50	516.17	133.65	27.33	1.105	14.55
60 cm × 30cm(S_2)	16.43	526.73	139.81	28.06	1.132	15.05
S.Em.±	0.17	7.45	2.205	0.83	0.005	0.125
C.D @ 5%	0.52	NS	NS	NS	0.015	0.379
Nutrient levels						
75 % RDN (F_1)	13.44	436.58	114.81	25.48	1.025	13.35
100 % RDN (F_2)	15.53	546.47	140.95	27.61	1.125	14.95
125 %RDN (F_3)	16.72	553.23	145.16	29.21	1.165	15.45
150 % RDN (F_4)	16.16	549.52	143.99	28.49	1.160	15.45
S.Em.±	0.245	10.53	3.119	1.172	0.007	0.176
C.D @ 5%	0.744	31.94	9.46	3.55	0.021	0.536
Interaction						
T_1- S1F1	13.21	432.87	109.33	24.50	1.01	13.10
T_2- S1F2	14.60	538.70	139.06	26.81	1.11	14.70
T_3- S1F3	15.30	550.18	143.43	28.30	1.15	15.10
T_4- S1F4	14.90	542.93	142.78	27.75	1.15	15.30
T_5- S2F1	13.67	440.30	120.30	26.47	1.04	13.60
T_6- S2F2	16.46	554.24	142.83	28.41	1.14	15.20
T_7- S2F3	17.51	556.28	146.90	30.12	1.18	15.80
T_8- S2F4	17.43	556.10	145.20	28.49	1.17	15.60
S.Em.±	0.34	14.89	4.41	1.658	1.01	0.250
C.D @ 5%	1.052	45.17	13.38	5.02	0.03	0.758

Table 2: Influence of spacing and graded level of NPK on yield and economics of Quality Protein Maize

Treatment	Grain yield kg ha^{-1}	Stover yield kg ha^{-1}	Protein (%)	Ash (g)	Net return (Rs)	B:C ratio
Spacing						
45 cm × 30cm(S_1)	4921	7799	10.55	1.465	36059	2.11
60 cm × 30cm(S_2)	4556	7389	10.72	1.497	31747	1.89
S.Em.±	111	22.5	0.115	0.006	5.24	0.05
C.D @ 5%	337	68.5	NS	0.018	15.88	0.17
Nutrient levels						

75 % RDN (F_1)	3893	7093	9.91	1.450	26619	1.85
100 % RDN (F_2)	4829	7741	10.28	1.475	35349	2.11
125 %RDN (F_3)	5143	7778	11.24	1.500	37569	2.12
150 % RDN (F_4)	5088	7764	11.09	1.500	36075	1.93
S.Em.±	157	31.9	0.163	0.008	7.41	0.08
C.D @ 5%	476	96.8	0.49	0.026	22.46	0.25
Interaction						
T_1- S1F1	4009	7241	9.91	1.440	28076	1.79
T_2- S1F2	4991	7963	10.41	1.450	37305	2.25
T_3- S1F3	5361	8009	10.99	1.470	40086	2.29
T_4- S1F4	5324	7981	10.90	1.500	38770	2.10
T_5- S2F1	3778	6044	9.93	1.460	25163	1.76
T_6- S2F2	4667	7518	10.15	1.500	33392	1.95
T_7- S2F3	4953	7546	11.49	1.530	35053	1.96
T_8- S2F4	4852	7546	11.29	1.500	33380	1.84
S.Em.±	222	45.17	0.23	0.012	10.47	0.12
C.D @ 5%	NS	137	NS	0.036	31.77	0.36

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