Effect of Precision Nitrogen Management through LCC on Nutrient Content and Uptake of Maize (*Zea mays* L.) under Temperate Conditions of Kashmir

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Original Research Article

ABSTRACT

Field experiment was conducted at Faculty of Agriculture, SKUAST-Kashmir, Wadura, Jammu and Kashmir during *kharif* seasons of 2019 and 2020 to assess the effect of precision nitrogen management through LCC on nutrient content and uptake of maize (*Zea mays* L.) under temperate conditions of Kashmir. The experiment comprised of three maize hybrids (SMH-2, Vivek-45 and Kanchan-517) assigned to main plots and seven Precision N management *viz.* nitrogen splits @ 20 and 30 kg N ha^{-1} managed through LCC (LCC scores of 3, 4 and 5), recommended nitrogen level and control in subplots. The treatments were replicated thrice in a split plot design. The results revealed that LCC ≤ 5 @ 30 kg N ha^{-1} recorded highest dry matter accumulation and periodic N uptake at all the stages of growth and highest P and K uptake by grain and straw at harvest.

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Further, highest dry matter accumulation and uptake of NPK was recorded in cultivar SMH-2 as compared to Vivek-45 and Kanchan-517 during 2019 and 2020 respectively. LCC based N application proved effective in increasing dry matter and nutrient content of maize hybrids.

1. INTRODUCTION

Maize is the third most important cereal crop of world and India after wheat and Rice. Maize has been an important cereal crop sowing to its highest production potential and adaptability to wide range of environment hence called as 'Queen of Cereals' [1]. In India, the crop is grown on an area of 9.38 million ha with the grain production of is 28.75 million tonnes, with an average productivity of 3065 kg ha^{-1} [2]. Nutrient management is important for sustainable crop production. Among the major nutrients, nitrogen management is essential for increasing N use efficiency as well as productive efficiency [3]. Nitrogen is the most critical nutrient element in crop production. It is vital for maintaining and improving crop growth and yield. The nitrogen demand of crop is met from native soil nitrogen supply and mineral fertilizer nitrogen application, where fertilizer N fills the gap between crop demand and native soil N supplies [4]. Further, the efficiency of N use decreases with increasing amounts of N applied [5]. Multiple split applications of mineral nitrogenous fertilizers can reduce N losses [6] and increases nitrogen use efficiency [7]. Greater soil N accumulation is due to mineralization of soil organic matter or greater root exploration in fertilized plants than unfertilized plants [8]. Nitrogen losses from the soil-plant system are large, leading to low fertilizer N use efficiency when N application is not synchronizing with crop demand. Efficiency could be improved if the timing and dosage of fertilizer were adjusted according to N supplying capacity of the soil and morphological development of the plant. Due to large variability for N supplying capacity of the native soil from farm to farm and plot to plot, the strategies of N fertilizer management should be responsive to the large variation of crop N requirements and soil N supply in order to achieve the synchrony of supply and demand and to improve N use efficiency. Blanket or package fertilizer recommendations over large areas are not efficient as indigenous nutrient supply varies widely among different fields in Asia. Farmers would benefit significantly if they can adjust N inputs to actual crop conditions and nutrient requirements.

2. MATERIALS AND METHODS

The field experiment entitle was conducted at Faculty of Agriculture, SKUAST-Kashmir, Wadura, Jammu and Kashmir during *kharif* seasons of 2019 and 2020 to assess the effect of precision nitrogen management through LCC on nutrient content and uptake of maize (*Zea mays* L.) under temperate conditions of Kashmir valley. The experiment comprised of three maize hybrids (SMH-2, Vivek-45 and Kanchan-517) assigned to main plots and seven Precision N management *viz*. nitrogen splits @ 20 and 30 kg N ha^{-1} managed through LCC (LCC scores of 3, 4 and 5), recommended nitrogen level and control in subplots. The treatments were replicated thrice in a split plot design. The experimental site was located at an altitude of 1590 m above mean sea level, $34^0 21^/$ N Latitude and $74^0 23^/$ E Longitude. The experimental site falls in mid altitude temperate zone with an average annual precipitation of 812 mm. The total rainfall received during the experimentation period was 371.5 and 303.0 mm during *Kharif* 2019 and 2020, respectively.The soil was neutral in reaction and medium in organic carbon, N, P and K with silty clay loam texture.

Plant samples contained in a quadrant 0.5 m x 0.5 m (0.25 m^2) were collected from each plot. The samples were collected periodically (30, 45, 60, 75, 90, 105 DAS and at harvest) from the field and then packed in labelled long paper bags. The samples were oven dried at 60-65°C for 48 hours till constant weight. The dry weight was recorded in grams and then converted into q ha^{-1}. Plant samples collected at harvest were collected and then packed in labelled long paper bags. These samples were put in an electric oven dried for 36 hours at 60-65°C temperature till constant weight was obtained. The oven dried plant samples were grinded with the help of Yarco grinder. The ground samples were put in labelled bags and chemical analysis was done. Nitrogen content was estimated by digesting 0.5 g sample with 10 ml concentrated sulphuric acid and digestion mixture as catalyst (K_2SO_4 or $CuSo_4$). Total nitrogen was determined by micro-Kjeldahls method [9]. N uptake by straw and grain of crop were calculated by multiplying dry

matter production with corresponding values of their content and was expressed as kg ha^{-1}. Phosphorus content (%) of ground samples was determined by "Vanadomolybdophosphoric acid yellow colour method" using spectrophotometer by digestion in tri acid mixture (HClO$_4$+ H$_2$SO$_4$+ HNO$_3$ at the rate of 3:1:10). Subsequently phosphorus uptake by straw and grain of crop were calculated by multiplying dry matter production with corresponding values of their content and was expressed as kg ha^{-1}. Potassium content (%) in the plant sample was determined by flame photometer [10]. K uptake by straw and grain of crop were calculated by multiplying dry matter production with corresponding values of their content and was expressed as kg ha^{-1}. The data obtained in respect of various observations were statistically analysed by method described by Cochran and Cox [11].

3. RESULTS AND DISCUSSION

3.1 Dry matter Accumulation (q ha^{-1})

Among the maize hybrids, Shalimar Maize Hybrid-2 recorded highest dry matter at all the periodic stages of growth as compared to Vivek-45 and Kanchan-517 (Table 1). The amount of dry matter produced by Shalimar Maize Hybrid-2 at harvest was 145.93 and 144.33 q ha^{-1} as compared to Vivek-45 (137.76 and 136.21 q ha^{-1}) and Kanchan-517 (125.92 and 123.51 q ha^{-1}) during 2019 and 2020, respectively. Significant effect of nitrogen management on maize hybrids were found in the dry matter accumulation at different periodic intervals during both the years. Nitrogen management through LCC ≤ 5 @ 30 kg N ha^{-1} produced significantly highest dry matter (146.21 and 144.26 q ha^{-1}) as compared to other LCC treatments but was at par with treatment LCC ≤ 5 @ 20 kg N ha^{-1} during 2019 and 2020, respectively. Application of nitrogen through LCC ≤ 4 @ 30 kg N ha^{-1} also produced significantly higher dry matter than LCC ≤ 3 @ 30 and 20 kg N ha^{-1} and recommended N level during both the years. Dry matter production is dependent upon the plant's metabolic activities and its corresponding growth. With higher leaf area and chlorophyll content, the plant exhibited higher photosynthetic activities which ultimately led to greater dry matter production [12]. Higher chlorophyll content can lead to higher photosynthetic rate by virtue of higher leaf N concentration, thereby resulting in greater biomass production.

3.2 Periodic N Content and Uptake

The data (Table 2) revealed that real time nitrogen management through LCC and maize hybrids did not affect N content significantly at any stage of the growth, however, N uptake varied significantly in different treatments at 30, 60 and 90 DAS during both the years. Among the three maize hybrids, Shalimar Maize Hybrid-2 recorded highest N uptake of 33.02 and 30.98 kg ha^{-1}, 160.18 and 155.54 kg ha^{-1} and 161.88 and 152.50 kg ha^{-1} as compared to Vivek-45 with N uptake of 28.61 and 27.59 kg ha^{-1}, 147.03 and 141.26 kg ha^{-1} and 145.45 and 135.84 kg ha^{-1} and Kanchan-517 recorded lowest N uptake of 26.08 and 24.38 kg ha^{-1}, 133.63 and 126.65 kg ha^{-1} and 127.73 and 118.32 kg ha^{-1} at 30, 60 and 90 DAS during 2019 and 2020, respectively. Real time N management through LCC ≤ 5 @ 30 kg N ha^{-1} recorded highest N uptake. Similarly, application of nitrogen through LCC ≤ 5 @ 20 kg N ha^{-1}, LCC ≤ 4 @ 30 and 20 kg N ha^{-1} recorded highest N uptake as compared to LCC ≤ 3 @ 30 and 20 kg N ha^{-1} and recommended N level whereas, LCC ≤ 3 @ 30 and 20 kg N ha^{-1} and recommended N level were at par with each other during both the years. The peak period of N uptake is at flowering stage and thereafter, there was a marked decline in N uptake at maturity which might be mainly due to reduction in N concentration in the plant caused by ammonia volatilization during transport of amides during the grain filling period and also due to the crop damage/losses caused by leaf senescence. Since nutrient uptake is a function of biomass production, the rapid increase in biomass has demanded more nutrients, thus resulting in higher rate of uptake [13]. These results are in close conformity with the findings of Zaman [14].

3.3 N Content and Uptake by Grain at Harvest

The data (Table 3) indicated that N content and N uptake through different LCC scores and maize hybrids were significantly influenced under different treatments during both the years of experimentation. Among the three maize hybrids, Shalimar Maize Hybrid-2 recorded highest N content of 1.41 and 1.35% and N uptake of 89.02 and 82.75 kg ha^{-1} by grain as compared to Vivek-45 with N content of 1.31 and 1.24 and N uptake of 68.82 and 62.25 kg ha^{-1} during 2019 and 2020, respectively. Real time N management through LCC ≤ 5 @ 30 kg N ha^{-1} recorded highest N uptake in grain but significantly superior to all other LCC scores and recommended N level during both the years. The

highest N uptake of 92.17 and 84.57 kg ha^{-1} by grain was recorded with LCC ≤ 5 @ 30 kg N ha^{-1}, followed by LCC ≤ 5 @ 20 kg N ha^{-1} with values of 84.21 and 76.96 kg ha^{-1} during 2019 and 2020, respectively. Most of the absorbed nitrogen is stored in the leaves and may be transported to the grains during grain filling. The findings are in close conformity with Yang et al. [15].

3.4 N Content and Uptake by Straw

The data (Table 3) revealed that different treatments had significant effect on N content and N uptake in straw during both the years. Among the three maize hybrids, Shalimar Maize Hybrid-2 recorded significantly higher N content of 0.54 and 0.50% and uptake of N with 60.29 and 54.62 kg ha^{-1} by straw in comparison to Vivek-45 which recorded uptake of 49.71 and 43.42 kg ha^{-1} during 2019 and 2020, respectively. Since nutrient uptake is a function of biomass production. The rapid increase in biomass in SMH-2 has demanded more nutrients, thus resulting in higher rate of N uptake [14]. Significant variation in N uptake among rice cultivars was recorded by Sikander et al. [16].

Real time N management through LCC ≤ 5 @ 30 kg N ha^{-1} recorded significantly highest N uptake by straw but significantly superior to LCC ≤ 5 @ 20 kg N ha^{-1}, LCC ≤ 4 @ 30 and 20 kg N ha^{-1}, LCC ≤ 3 @ 30 and 20 kg N ha^{-1} and recommended N level during both the years. The highest N uptake by straw recorded with LCC ≤ 5 @ 30 kg N ha^{-1} was 72.55 and 65.08 kg ha^{-1}, followed by LCC ≤ 5 @ 20 kg N ha^{-1} with 65.27 and 58.15 kg ha^{-1}during 2019 and 2020, respectively. Since nutrient uptake is a function of biomass production, the rapid increase in biomass has demanded more nutrients, thus resulting in higher rate of uptake [13]. The uptake of N may also be higher due to, frequent application of mineral N besides greater mineralization of native N, as evidenced by significantly higher availability of N in the soils even after harvest of maize under N management through LCC at higher thresholds [17]. The lower total N uptake with fixed schedule recommended N application method than with LCC managed N could be associated with suboptimal rates of N application in the recommendation, which could have limited maize growth [13].

3.5 P Content and Uptake by Grain

The data (Table 4) revealed that P content does not vary due to maize hybrids and N

management practices through LCC, however significant variation in P uptake by grain was found between maize hybrids and different treatments during both the years of experimentation. Three maize hybrids varied significantly with respect to P uptake during both the years. Shalimar Maize Hybrid-2 recorded highest uptake of P with 36.79 and 33.36 kg ha^{-1} by grain as compared to Vivek-45 and Kanchan-517 during 2019 and 2020, respectively. However, lowest uptake of P with 23.72 and 22.40 kg ha^{-1} by grain were recorded in Kanchan-57 during 2019 and 2020, respectively. LCC ≤ 5 and LCC ≤ 4 @ 30 and 20 kg N ha^{-1} recorded highest P uptake by grain and were significantly superior to other LCC scores and recommended N level during both the years. The highest P uptake by grain recorded with LCC ≤ 5 @ 30 kg N ha^{-1} was 37.37 and 34.30 kg ha^{-1}, followed with 34.44 31.49 kg ha^{-1} by LCC ≤ 5 @ 20 kg N ha^{-1} during 2019 and 2020, respectively. Since nutrient uptake is a function of biomass production, the rapid increase in biomass has demanded more nutrients, thus resulting in higher rate of uptake. The results are supported by the findings of Gupta et al. [13].

3.6 P Content and Uptake by Straw

The data (Table 4) revealed that different LCC scores and maize hybrids did not varied significantly in P content by straw but had significant effect on P uptake during both the years. Among the three maize hybrids, Shalimar Maize Hybrid-2 recorded significantly highest uptake of P with 29.13 and 26.30 kg ha^{-1} by straw in as compared to Vivek-45 and Kanchan-517 during 2019 and 2020, respectively. The lowest uptake of P with 20.94 and 19.29 kg ha^{-1} by straw were recorded in Kanchan-57 during 2019 and 2020, respectively. Application of nitrogen through LCC ≤ 5 @ 30 kg N ha^{-1} recorded highest P uptake by straw but significantly superior to LCC ≤ 5 @ 20 kg N ha^{-1} and LCC ≤ 4 @ 30 kg N ha^{-1}, LCC ≤ 3 @ 30 and 20 kg N ha^{-1} and recommended N level during both the years. The highest P uptake by straw was 34.11 and 31.74 kg ha^{-1} and 30.66 and 28.42 kg ha^{-1} recorded with LCC ≤ 5 @ 30 kg N ha^{-1} and LCC ≤ 5 @ 20 kg N ha^{-1}during 2019 and 2020, respectively. Since nutrient uptake is a function of biomass production, the rapid increase in biomass has demanded more nutrients, thus resulting in higher rate of uptake [13]. The results are supported by the findings of Zaman [14].

Table 1. Effect of Real time nitrogen management through LCC on dry matter accumulation (q ha⁻¹) of different hybrid maize cultivars

Treatments	30 DAS		45 DAS		60 DAS		75 DAS		90 DAS		105 DAS		Harvest	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Hybrids														
Shalimar Maize Hybrid-2	23.25	22.61	43.08	42.94	66.74	65.63	109.37	107.82	130.55	128.15	140.58	139.46	145.93	144.33
Vivek-45	21.35	21.22	38.94	37.50	63.65	62.23	104.48	102.69	125.39	123.49	133.19	132.32	137.76	136.21
Kanchan-517	20.22	19.35	35.83	34.23	58.87	57.05	99.28	97.76	117.18	116.00	123.39	120.99	125.92	123.51
SE(m) ±	0.40	0.51	0.42	0.73	0.86	0.95	2.23	1.88	2.96	2.59	2.97	2.79	2.69	2.56
C.D. (p≤0.05)	1.22	1.53	1.25	2.21	2.59	2.85	6.71	5.65	8.89	7.77	8.91	8.37	8.07	7.69
Nitrogen management														
Control	10.53	9.96	28.24	26.44	48.2	46.49	89.29	87.61	109.22	107.13	116.67	114.53	119.29	117.94
Recommended N	20.58	20.32	39.19	38.38	62.22	61.33	103.94	102.23	123.66	122.07	131.62	130.33	136.83	134.89
LCC ≤ 3@20 kg N ha⁻¹	20.34	19.28	37.16	36.25	61.49	59.20	101.81	99.42	121.73	120.54	129.49	128.20	134.7	132.76
LCC ≤ 3@30 kg N ha⁻¹	20.46	20.00	38	37.13	60.27	60.03	102.99	100.61	122.61	121.12	130.67	129.38	135.88	133.94
LCC ≤ 4@20 kg N ha⁻¹	22.82	22.19	40.43	39.13	64.16	62.68	106.28	105.90	126.21	124.42	134.96	133.68	138.18	136.23
LCC ≤ 4@30 kg N ha⁻¹	24.08	24.46	41.7	40.59	66.23	64.94	107.55	106.16	127.47	125.68	136.23	134.94	139.44	137.50
LCC ≤ 5@20 kg N ha⁻¹	25.41	24.79	43.13	42.32	68.36	66.47	109.88	108.34	129.80	127.01	137.56	136.37	141.77	139.83
LCC ≤ 5@30 kg N ha⁻¹	28.63	27.44	46.44	45.54	73.79	71.98	113.31	111.83	134.24	132.45	141.89	139.91	146.21	144.26
SE(m) ±	0.46	0.55	0.49	0.42	0.58	0.50	0.69	0.67	0.85	0.77	0.75	0.69	0.72	0.65
C.D. (p≤0.05)	1.39	1.67	1.47	1.26	1.71	1.52	2.08	2.03	2.56	2.32	2.26	2.09	2.16	1.96

Table 2. Effect of Real time nitrogen management through LCC on N content (%) and uptake (kg ha^{-1}) of different hybrid maize cultivars at periodic interval

Treatments	30 DAS								90 DAS			
	N Content		N Uptake		N Content		N Uptake		N Content		N Uptake	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Hybrids												
Shalimar Maize Hybrid-2	1.42	1.37	33.02	30.98	2.40	2.37	160.18	155.54	1.24	1.19	161.88	152.50
Vivek-45	1.34	1.30	28.61	27.59	2.31	2.27	147.03	141.26	1.16	1.10	145.45	135.84
Kanchan-517	1.29	1.26	26.08	24.38	2.27	2.22	133.63	126.65	1.09	1.02	127.73	118.32
SE(m) ±	0.05	0.06	1.41	0.70	0.06	0.07	2.46	2.89	0.06	0.07	3.30	3.07
C.D. (p≤0.05)	NS	NS	4.22	2.12	NS	NS	7.40	8.67	NS	NS	9.92	9.28
Nitrogen management												
Control	1.15	1.10	12.11	10.96	1.97	1.92	94.95	89.26	0.88	0.81	96.11	86.78
Recommended N	1.28	1.23	26.34	24.99	2.24	2.19	139.37	134.31	1.08	1.01	133.55	123.29
Lcc ≤ 3@20 kg N ha^{-1}	1.25	1.20	25.43	23.14	2.2	2.15	135.28	127.28	1.03	0.96	125.38	115.72
Lcc ≤ 3@30 kg N ha^{-1}	1.30	1.25	26.60	25.00	2.27	2.22	136.81	133.27	1.1	1.03	134.87	124.75
Lcc ≤ 4@20 kg N ha^{-1}	1.39	1.36	31.72	30.18	2.37	2.34	152.06	146.67	1.21	1.16	152.71	144.33
Lcc ≤ 4@30 kg N ha^{-1}	1.42	1.39	34.19	34.00	2.41	2.38	159.61	154.56	1.27	1.22	161.89	153.33
Lcc ≤ 5@20 kg N ha^{-1}	1.47	1.44	37.35	35.70	2.53	2.50	172.95	166.18	1.3	1.25	168.74	158.76
Lcc ≤ 5@30 kg N ha^{-1}	1.56	1.53	44.66	41.98	2.68	2.65	197.76	190.75	1.41	1.36	189.28	180.13
SE(m) ±	0.03	0.02	1.76	1.34	0.05	0.06	4.62	5.07	0.03	0.04	4.74	4.25
C.D. (p≤0.05)	0.09	0.06	5.28	4.02	0.15	0.18	13.88	15.22	0.09	0.12	14.24	12.75

Note: The "60 DAS" header spans the 5th–8th data column group (N Content 2019/2020, N Uptake 2019/2020).

Table 3. Effect of Real time nitrogen management through LCC on N content and uptake (kg ha^{-1}) of different hybrid maize cultivars

Treatments	N content in Grain		N content in straw		N uptake by grain		N uptake by straw	
	2019	2020	2019	2020	2019	2020	2019	2020
Hybrids								
Shalimar Maize Hybrid-2	1.41	1.35	0.54	0.50	89.02	82.75	60.29	54.62
Vivek-45	1.31	1.24	0.49	0.44	68.82	62.25	49.71	43.42
Kanchan-517	1.27	1.18	0.45	0.38	59.89	52.64	43.74	36.19
SE(m) ±	0.01	0.01	0.01	0.01	1.06	1.16	0.64	1.74
C.D. (p≤0.05)	0.04	0.04	0.05	0.04	4.14	4.54	1.84	6.83
Nitrogen management								
Control	1.16	1.08	0.29	0.23	47.50	40.5	24.55	19.57
Recommended N	1.28	1.21	0.43	0.38	67.58	61.12	44.32	37.97
Lcc ≤ 3@20 kg N ha^{-1}	1.24	1.16	0.40	0.35	65.01	58.51	39.64	33.60
Lcc ≤ 3@30 kg N ha^{-1}	1.30	1.23	0.47	0.42	69.10	62.58	47.35	41.00
Lcc ≤ 4@20 kg N ha^{-1}	1.35	1.27	0.53	0.48	75.69	68.83	55.78	49.01
Lcc ≤ 4@30 kg N ha^{-1}	1.40	1.32	0.57	0.52	79.37	72.35	60.51	53.57
Lcc ≤ 5@20 kg N ha^{-1}	1.43	1.35	0.61	0.56	84.21	76.96	65.27	58.15
Lcc ≤ 5@30 kg N ha^{-1}	1.49	1.41	0.65	0.60	92.17	84.57	72.55	65.08
SE(m) ±	0.01	0.01	0.003	0.003	1.67	1.61	1.05	0.58
C.D. (p≤0.05)	0.03	0.03	0.01	0.01	4.77	4.61	3.01	1.68

Table 4. Effect of Real time nitrogen management through LCC on P content (%) and uptake (kg ha^{-1}) of different hybrid maize cultivars

Treatments	P content in Grain		P content in straw		P uptake by grain		P uptake by straw	
	2019	2020	2019	2020	2019	2020	2019	2020
Hybrids								
Shalimar Maize Hybrid-2	0.47	0.49	0.26	0.25	29.30	29.72	28.59	26.30
Vivek-45	0.45	0.46	0.25	0.24	23.36	22.86	24.64	22.91
Kanchan-517	0.44	0.45	0.22	0.21	20.42	19.76	20.94	19.29
SE(m) ±	0.03	0.02	0.04	0.03	1.52	1.30	1.22	1.12
C.D. (p≤0.05)	NS	NS	NS	NS	4.58	3.90	3.67	3.36
Nitrogen management								
Control	0.39	0.41	0.19	0.18	15.85	15.38	15.82	14.45
Recommended N	0.44	0.46	0.22	0.21	22.92	22.98	22.25	20.60
LCC ≤ 3@20 kg N ha^{-1}	0.42	0.45	0.21	0.20	21.71	22.30	20.38	18.80
LCC ≤ 3@30 kg N ha^{-1}	0.45	0.46	0.23	0.22	23.61	23.15	22.80	21.14
LCC ≤ 4@20 kg N ha^{-1}	0.47	0.49	0.24	0.23	26.14	26.21	24.86	23.13
LCC ≤ 4@30 kg N ha^{-1}	0.47	0.48	0.26	0.25	26.47	26.00	27.15	25.35
LCC≤ 5@20 kg N ha^{-1}	0.48	0.49	0.29	0.28	28.02	27.56	30.66	28.25
LCC ≤ 5@30 kg N ha^{-1}	0.48	0.49	0.31	0.29	29.41	28.97	34.11	31.02
SE(m) ±	0.05	0.04	0.06	0.05	0.91	0.79	1.06	1.00
C.D. (p≤0.05)	NS	NS	NS	NS	2.74	2.38	3.18	3.02

Table 5. Effect of Real time nitrogen management through LCC on K content (%) and uptake (kg ha⁻¹) of different hybrid maize cultivars

Treatments	K content in Grain		K content in straw		K uptake by grain		K uptake by straw	
	2019	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**
Hybrids								
Shalimar Maize Hybrid-2	0.31	0.28	1.30	1.26	19.33	16.98	140.27	132.55
Vivek-45	0.29	0.27	1.26	1.23	15.06	13.42	124.17	117.40
Kanchan-517	0.27	0.24	1.20	1.18	11.86	10.54	114.22	108.42
SE(m) ±	0.02	0.03	0.03	0.04	1.19	0.80	2.90	2.65
C.D. (p≤0.05)	NS	NS	NS	NS	3.58	2.40	8.70	7.96
Nitrogen management								
Control	0.22	0.19	1.16	1.13	8.94	7.12	96.60	90.68
Recommended N	0.26	0.23	1.22	1.19	13.55	11.69	123.39	116.75
Lcc ≤ 3@20 kg N ha⁻¹	0.25	0.22	1.20	1.17	12.93	11.10	116.45	109.99
Lcc ≤ 3@30 kg N ha⁻¹	0.28	0.25	1.24	1.21	14.69	12.78	122.91	116.26
Lcc ≤ 4@20 kg N ha⁻¹	0.30	0.27	1.27	1.24	16.69	14.65	131.55	124.69
Lcc ≤ 4@30 kg N ha⁻¹	0.32	0.29	1.28	1.25	18.02	15.93	133.67	126.75
Lcc ≤ 5@20 kg N ha⁻¹	0.34	0.31	1.30	1.27	19.85	17.66	137.46	130.44
Lcc ≤ 5@30 kg N ha⁻¹	0.36	0.33	1.33	1.30	22.06	19.75	146.33	139.07
SE(m) ±	0.06	0.05	0.07	0.08	0.70	0.66	1.98	1.18
C.D. (p≤0.05)	NS	NS	NS	NS	2.10	1.98	5.94	3.56

3.7 K Content and Uptake by Grain

The data (Table 5) indicated that K content by grain was not significantly influenced through different LCC scores but had significant effect on K uptake by grain during both the years. Maize hybrids varied significantly with respect to K uptake during both the years. Shalimar Maize Hybrid-2 recorded highest K uptake of 19.33 and 16.98 kg ha^{-1} by grain as compared to Vivek-45 with 15.06 and 13.42 kg ha^{-1} and the lowest K uptake of 11.86 and 10.54 kg ha^{-1} were recorded in Kanchan-517 during 2019 and 2020, respectively. Real time N management through LCC ≤ 5 @ 30 kg N ha^{-1} recorded highest K uptake by grain but was significantly superior to LCC ≤ 5 @ 20 kg N ha^{-1}, LCC ≤ 4 @ 30 and 20 kg N ha^{-1}, LCC ≤ 3 @ 30 and 20 kg N ha^{-1} and recommended N level during both the years. Highest K uptake recorded with LCC ≤ 5 @ 30 kg N ha^{-1} was 22.06 and 19.75 kg ha^{-1} followed by LCC ≤ 5 @ 20 kg N ha^{-1} with 19.85 and 17.66 kg ha^{-1} during 2019 and 2020, respectively. Since nutrient uptake is a function of biomass production, the rapid increase in biomass has demanded more nutrients, thus resulting in higher rate of uptake [13]. The results are supported by the findings of Zaman [14].

3.8 K Content and Uptake by Straw

The data (Table 5) revealed that K content by straw does not vary significantly under different treatments, however, K uptake varied significantly at different scores of LCC during both the years. Maize hybrids significantly influenced K uptake during both the years. Shalimar Maize Hybrid-2 recorded highest uptake of K with 140.27 and 132.55 kg ha^{-1} by straw and the Kanchan-517 recorded lowest uptake of K with 114.22 and 108.42 kg ha^{-1} during 2019 and 2020, respectively. It was found that LCC ≤ 5 @ 30 kg N ha^{-1} recorded highest K uptake by straw followed by LCC ≤ 5 @ 20 kg N ha^{-1} which was at par with LCC ≤ 4 @ 30 and kg N ha^{-1} but significantly superior to LCC ≤ 3 @ 30 and 20 kg N ha^{-1} and recommended N level during both the years. The highest K uptake by straw recorded with LCC ≤ 5 @ 30 kg N ha^{-1} was 146.33 and 139.07 kg ha^{-1} followed by LCC ≤ 5 @ 20 kg N ha^{-1} with 137.46 and 130.44 kg ha^{-1} during 2019 and 2020, respectively. Since nutrient uptake is a function of biomass production, the rapid increase in biomass has demanded more nutrients, thus resulting in higher rate of uptake [13]. The results are supported by the findings of Zaman [14].

4. CONCLUSION

Real time nitrogen management through LCC proved to be effective and efficient method of nitrogen application in maize hybrids for maximizing dry matter production and nitrogen uptake as compared to blanket application of nitrogen.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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