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Impact of Potassium Nutrition on Fruit Yield and Physico-chemical Characteristics of Apple Cultivar Red Delicious

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Abstract

Field experiments were conducted in a randomized complete block design (RCBD) with four doses of potassium (K) {2.5, 3.0, 3.5 and 4.0 kg muriate of potash (MOP) tree^{-1}} applied in two, three and four equal splits to access the effect of K on fruit quality of apple cultivar Red Delicious during 2015-16 and 2016-17. Results revealed that the K application @ 2.5 to 3.0 kg MOP tree^{-1} was optimum in producing quality fruits. Potassium applied in four equal splits improved the K use and had a significant benficial impact on the physico-chemical characters of the apple fruits.

Key words: Apple, Red Delicious, potassium, fruit quality, bitter pit, nutrient status

Introduction

Apple is amongst the most consumed fruits in the world. It is cultivated on 227,000 ha area with a production of 2.24 million tonnes (Mt) (Anonymous, 2016-17). In the state of Jammu and Kashmir, apple cultivated on 162971 ha area produced 1,726,834 tonnes (t) fruits in 2015-16 (Anonymous, 2016). Most of the apple cultivation in Kashmir is done in *karewas*, which are devoid of irrigation facility and the crop remains mostly under water stress; These conditions adversely impact the potential yields and fruit quality. As apple crop constitutes the backbone of Kashmir's economy, focus on all the measures including on-time proper nutrition of the trees for getting a high yield of good quality apples becomes a must.

Potassium (K), one of the major essential nutrients and often described as the quality element plays an important role in promoting synthesis of photosynthates and their transport to fruits, formation of starch, and protein synthesis. Potassium has profound influence on fruit quality of apple through its influence on size, colour appearance and soluble solids (Taiz and Zeiger, 2004; Anjum et al., 2008). It promotes strong vigorous tree growth, boosts fruit size and cell strength and encourages good tolerance to insect pests and diseases. Potassium has a well-known function in water regulation and uptake in crops under water stress as it facilitates the turgor pressure of guard cells during opening and closing of stomata. The quality of the fruit depends on proper nutrient supply and may deteriorate under improper nutritional supplies. It has been shown that apple crop removes two times more K than nitrogen (N). Insufficient K levels cause nutrient imbalances; however, over-dose or higher dose of K also adversely affect the fruit quality by competitively restricting the calcium (Ca) uptake. Aim of this study was to assess the influence of rates of K-fertilizer (muriate of potash, MOP) applied in 2, 3 and 4 splits on the K and Ca content of leaf and fruit tissues, yield, and quality of fruits of apple cultivar Red Delicious.

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Material and Methods

Experiments were laid out in the farmers' fields in Baramulla and Ganderbal districts of Jammu and Kashmir at two locations in each district for two years (2015-16 and 2016-17). Randomized block design (RBD) was followed at each site with 3 replications and five trees were taken as a plot size. Twenty year-old Red Delicious trees grafted on seedling rootstock with uniform vigour were selected for study. Treatment combinations consisted of four rates of muriate of potash (MOP) namely, 2.5 kg (K_1) (which is also a recommended dose for the mature apple tree), 3.0 kg (K_2), 3.5 kg (K_3) and 4.0 kg (K_4) tree^{-1} year^{-1}. These doses of MOP were applied in two (D_1), three (D_2) and four (D_3) splits. First dose of potassium was applied 21 days before expected bloom and the second was applied one month after bloom. Third and fourth doses were applied two and three months after bloom as per the technical programme drawn at the start of the experiment. Urea (1.5 kg tree^{-1}) and DAP (0.75 kg tree^{-1}) were applied as per the recommendations of Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir (SKUAST-K), Shalimar. Farmer's practice of applying 2.5 kg MOP tree^{-1} in two splits was used as a control. Data on fruit yield, quality, nutrient content in leaves and fruits were recorded and analyzed by following the standard precedures.

Results and Discussion

Fruit Yield

Increased rates of K application were associated with the higher fruit yields (**Table 1**). Averaged over splits, increase in rate of MOP from 2.5 kg $tree^{-1}$ to 3.5 kg $tree^{-1}$ increased the mean fruit yield from 104.7 kg $tree^{-1}$ to 119.2 kg $tree^{-1}$ during the first year (2015-16). However, in the 2nd year (2016-17), highest yield (205.9 kg $tree^{-1}$) was recorded for the trees receiving 3.5 kg MOP $tree^{-1}$. Observed variation across two years could be attributed to the fact that the trees were highly deficient in K because of non-application of K fertilizers in the previous years. Increase in the number of splits also caused increase in the fruit yields. Highest mean yield (152.3 kg MOP $tree^{-1}$ $year^{-1}$) was obtained where MOP was applied in four split doses. Increase in K use efficiency with more number of splits could be the prime reason for the observed yield increase.

Firmness

In the 1st year of study, maximum fruit firmness was noted when 3.5 kg MOP $tree^{-1}$ was applied in four split doses; however, in the 2nd year, more firmness was recorded when 4.0 kg MOP was supplemented through four splits (**Table 2**). These results corroborate the earlier findings of Wani and Khajwall (1997) who reported that the K application increases osmoregulation of cell vacuoles and maintains the equilibria, which imparts firmness to the fruits. On the contrary, decrease in fruit firmness with increase in K application has also been reported by Naiema (2003) and Wojcik (2005). These authors propounded that Ca content in the fruit sharply decreases with increase in the rate of K application and as Ca is an important constituent of the cell wall, very low Ca concentration adversely affects the cell wall formation, and by implications the fruit firmness. Lester et al. (2007) also reported similarly.

Table 1. Influence of fertilizer potassium on yield (kg $tree^{-1}$ $year^{-1}$) of apple cultivar Red Delicious

Rate of MOP (kg $tree^{-1}$)	Two splits		Three splits		Four splits		Mean		Two years' mean
	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	
2.5	96.8	162.8	105.5	167.8	111.7	165.8	104.7	165.3	135.0
3.0	109.0	161.6	106.3	189.4	116.4	186.2	110.5	179.1	144.8
3.5	114.6	208.0	115.7	201.3	117.7	208.3	116.0	205.9	160.9
4.0	117.2	199.0	120.0	194.1	120.4	192.1	119.2	195.0	157.1
Mean	109.4	182.8	111.8	188.0	116.6	188.1			
Two years' mean	146.1		149.9		152.3				
CD (P = 0.05)									
MOP rate	3.0	3.7							
Split doses	2.6	3.2							

Table 2. Influence of fertilizer potassium on fruit firmness (lbs $inch^{-2}$) of Red delicious

Rate of MOP (kg $tree^{-1}$)	Two splits		Three splits		Four splits		Mean		Two years' mean
	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	
2.5	10.77	9.65	10.82	9.18	11.93	8.90	11.17	9.25	10.21
3.0	11.85	11.43	12.43	11.50	12.93	11.73	12.40	11.56	11.98
3.5	12.50	9.69	13.68	9.77	15.49	10.14	13.89	9.87	11.88
4.0	12.28	10.37	12.12	10.69	11.94	11.04	12.11	10.70	11.405
Mean	11.85	10.29	12.26	10.29	13.07	10.45			
Two years' mean	11.07		11.275		11.76				
CD (P = 0.05)									
MOP rate	0.69	0.37							
Split doses	0.060	NS							

Table 3. Influence of fertilizer potassium on TSS (°Brix) of Red Delicious

Rate of MOP (kg tree^{-1})	Two splits		Three splits		Four splits		Mean		Two years' mean
	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	
2.5	9.97	9.38	10.11	9.67	10.93	9.53	10.34	9.53	9.94
3.0	10.25	10.03	11.70	10.18	12.39	10.28	11.45	10.16	10.81
3.5	11.12	12.35	12.52	12.88	13.74	13.53	12.46	12.92	12.69
4.0	10.45	11.02	12.34	11.15	12.91	12.03	11.90	11.39	11.65
Mean	10.45	10.69	11.67	10.97	12.49	11.34			
Two years' mean	10.57		11.32		11.92				
CD (P = 0.05)									
MOP rate	0.51	0.19							
Split doses	0.44	0.17							

Total Soluble Solids

Increase in rate of MOP application up to 3.5 kg MOP tree^{-1} caused a significant increase in the total soluble solids (TSS) content in both the years. Maximum TSS (12.69 °Brix) was recorded when trees were fertilized with 3.5 kg MOP tree^{-1} followed by 4.0 kg tree^{-1} year^{-1} (11.65 °Brix) (**Table 3**). The TSS content was significantly lower (9.94 °Brix) in the fruits which had received only 2.5 kg MOP tree^{-1} year^{-1}. Application of MOP in split doses had also significant effect on TSS of apple fruits. More the number of split doses, higher was the TSS content recorded in the fruits. Highest TSS (11.92 °Brix) was observed in fruits receiving potassium in four splits as compared to two splits (10.57 °Brix). This happened because K is involved in the loading of sugars into phloem which allows the translocation of sugars from source tissues to supply the needs of growing organs like fruits and roots (Taiz and Zeiger, 2004). These results also corroborate the findings of Lacombe et al. (2000). Increase in the TSS content with increase in number of splits is due to enhancement in the MOP use efficiency (Yousf et al., 2018).

Fruit Length and Breadth

Increase in the rate of MOP application from 2.5 to 3.5 kg tree^{-1} year^{-1} caused significant increase in the length of apple fruits from 6.55 to 7.56 cm; reduction in fruit length to 7.03 cm occurred with the application of 4.0 kg MOP tree^{-1} year^{-1} (**Table 4**). Similarly, significant effect of potassium fertilization was recorded with increase in the number of splits. Maximum fruit length (7.20 cm) was noticed when MOP was added in four splits and it was minimum (6.88 cm) under two splits.

Fruit requires more K than any other nutrient and its size is positively correlated with leaf K content (Stiles and Reid, 1991). This could also be due to higher cell division and elongation, and translocation of photosynthates to the sink on account of K fertilization. These results are in accordance with the findings of Neilsen and Neilsen (2006).

Table 4. Influence of fertilizer potassium on fruit length (cm) of Red Delicious

Rate of MOP (kg tree^{-1})	Two splits		Three splits		Four splits		Mean		Two years' mean
	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	
2.5	6.50	6.66	6.70	6.76	6.62	6.91	6.60	6.78	6.69
3.0	6.61	6.99	6.83	6.97	6.86	7.23	6.77	7.06	6.91
3.5	7.36	7.75	7.61	7.84	7.97	8.00	7.64	7.86	7.75
4.0	6.55	6.68	6.64	6.92	7.18	6.83	6.79	6.81	6.8
Mean	6.75	7.02	6.94	7.12	7.16	7.24			
Two years' mean	6.88		7.03		7.2				
CD (P = 0.05)									
MOP rate	0.33	0.21							
Split doses	0.28	NS							

Table 5. Influence of fertilizer potassium on fruit breadth (cm) of Red Delicious

Rate of MOP (kg tree^{-1})	Two splits		Three splits		Four splits		Mean		Two years' mean
	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	
2.5	6.50	6.82	6.70	6.89	6.62	6.86	6.60	6.86	6.73
3.0	6.61	7.34	6.83	7.41	6.86	7.51	6.77	7.42	7.09
3.5	7.36	7.07	7.61	7.02	7.97	7.10	7.64	7.28	7.46
4.0	6.55	6.66	6.64	6.71	7.18	6.61	6.79	6.66	6.72
Mean	6.75	6.97	6.94	7.00	7.16	7.02			
Two years' mean	6.86	6.97	7.09						
CD (P = 0.05)									
MOP rate	0.33	0.09							
Split doses	0.28	NS							

Fruit breadth also showed a significant increase from 6.73 cm under 2.5 kg MOP tree^{-1} year^{-1} to 7.46 cm under 3.5 kg MOP tree^{-1} year^{-1}; further increase of MOP dose to 4.0 kg MOP tree^{-1} year^{-1} caused reduction in the breadth of fruits (**Table 5**). These results corroborate the findings of Neilsen and Neilsen (2006).

Bitter Pit Incidence and Physiological Loss in Weight

Significant increase in bitter pit incidence was apparent following the application of higher MOP doses. Maximum bitter pit incidence (8.78%) was recorded under the highest rate of MOP application (4.0 kg tree^{-1} year^{-1}). This incidence went on decreasing with reduction in the MOP application rates (**Table 6**). Likewise, reduction in bitter pit incidence was noticed when same amount of MOP was applied in more number of splits.

Potassium had a significant influence on physiological loss in weight (**Table 7**). On an average, significantly higher physiological loss in weight (8.33%) was noted in fruits harvested from trees receiving 4.0 kg MOP tree^{-1} year^{-1} as compared to 2.5 kg MOP tree^{-1} year^{-1} (4.62%). Influence of splits on this parameter was significant only in the first year. Nava et al. (2008) reported that the increase in

Table 6. Influence of fertilizer potassium on bitter pit incidence (%) of Red Delicious

Rate of MOP (kg tree^{-1})	Two splits		Three splits		Four splits		Mean		Two years' mean
	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	
2.5	6.30	4.17	5.92	4.25	5.13	4.11	5.78	4.18	4.98
3.0	9.00	6.46	8.61	5.59	8.62	5.63	8.75	5.89	7.32
3.5	11.59	5.93	10.25	5.09	10.21	5.13	10.68	5.38	8.03
4.0	9.53	8.55	9.34	8.68	8.15	8.41	9.01	8.55	8.78
Mean	9.10	6.28	8.53	5.90	8.03	5.82			
Two years' mean	7.69		7.22		6.93				
CD (P = 0.05)									
MOP rate	0.54	0.52							
Split doses	0.47	NS							

Table 7. Influence of fertilizer potassium on physiological loss in weight (%) of Red Delicious after 30 days of ambient storage

Rate of MOP (kg tree^{-1})	Two splits		Three splits		Four splits		Mean		Two years' mean
	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	
2.5	5.41	4.40	4.77	4.37	4.32	4.43	4.83	4.40	4.62
3.0	5.46	6.12	4.45	5.41	4.18	4.63	4.69	5.38	5.03
3.5	6.74	9.49	7.32	8.18	5.41	7.65	6.49	8.44	7.46
4.0	8.72	9.26	9.11	8.56	6.14	8.23	7.99	8.68	8.33
Mean	6.58	7.31	6.41	7.63	6.01	7.98			
Two years' mean	6.24		6.52		6.99				
CD (P = 0.05)									
MOP rate	0.47	0.46							
Split doses	NS	0.39							

Table 8. Influence of fertilizer potassium on leaf nitrogen (%) of Red Delicious

Rate of MOP (kg tree^{-1})	Two splits		Three splits		Four splits		Mean		Two years' mean
	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	
2.5	1.71	1.23	1.74	2.38	1.82	2.22	1.76	1.94	1.85
3.0	1.98	2.31	2.02	2.41	2.12	2.58	2.04	2.44	2.24
3.5	1.71	2.13	1.72	2.14	1.90	2.12	1.78	2.13	1.96
4.0	1.65	2.10	1.75	2.17	1.82	2.14	1.74	2.14	1.94
Mean	1.76	1.94	1.81	2.27	1.91	2.27			
Two years' mean	1.85		2.04		2.09				
CD (P = 0.05)									
MOP rate	0.09	0.03							
Split doses	0.07	0.02							

potassium uptake decreases the flesh firmness and increases the physiological loss in weight. Argenta (2002) also concluded that the storage life of apple decreases with increase in the rates of K application. Excessive K supply, however, can negatively affect the fruit Ca content, leading to calcium deficiency-induced disorders such as bitter pit (Cheng, 2013).

Mineral Nutrient Content in Leaf and Fruit

Nitrogen Content

With increase in rate of MOP application from 2.5 kg tree^{-1} year^{-1} to 3.0 kg tree^{-1} year^{-1} mean N content in the leaf increased from 1.85 to 2.24%; further rise in MOP rate was associated with decrease in the leaf N, dropping to 1.94% under 4.0 kg MOP tree^{-1} year^{-1} (**Table 8**). With every increase in split, nitrogen content of leaves recorded a rise. Maximum leaf N content (2.09%) in leaf was recorded when fertilizer was applied in four splits as compared to two splits (1.85%). Pattern of fruit N content was almost similar to that recorded for leaf N. As presented in **Table 9,** the mean N content of apple fruits first increased from 0.257% under 2.5 kg MOP tree^{-1} year^{-1} to 0.342% under 3.0 kg MOP

Table 9. Influence of fertilizer potassium on fruit nitrogen (%) of Red Delicious

Rate of MOP (kg tree^{-1})	Two splits		Three splits		Four splits		Mean		Two years' mean
	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	
2.5	0.17	0.35	0.17	0.35	0.16	0.34	0.17	0.35	0.26
3.0	0.30	0.36	0.35	0.35	0.36	0.35	0.33	0.35	0.34
3.5	0.22	0.34	0.25	0.34	0.26	0.31	0.24	0.33	0.29
4.0	0.14	0.32	0.15	0.31	0.15	0.31	0.15	0.31	0.23
Mean	0.21	0.34	0.23	0.34	0.23	0.33			
Two years' mean	0.28		0.28		0.28				
CD (P = 0.05)									
MOP rate	0.02	0.04							
Split doses	0.02	0.04							

Table 10. Influence of fertilizer potassium on fruit phosphorus (%) of Red Delicious

Rate of MOP (kg tree^{-1})	Two splits		Three splits		Four splits		Mean		Two years' mean
	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	
2.5	0.140	0.002	0.140	0.004	0.140	0.005	0.141	0.004	0.072
3.0	0.140	0.003	0.120	0.002	0.120	0.004	0.130	0.003	0.066
3.5	0.110	0.005	0.100	0.008	0.100	0.005	0.102	0.006	0.053
4.0	0.140	0.003	0.120	0.004	0.120	0.003	0.121	0.003	0.061
Mean	0.130	0.004	0.120	0.004	0.120	0.004			
Two years' mean	0.067		0.062		0.062				
CD (P = 0.05)									
MOP rate	0.007	0.0002							
Split doses	0.006	0.0002							

Table 11. Influence of fertilizer potassium on leaf potassium (%) of Red Delicious

Rate of MOP (kg $tree^{-1}$)	Two splits		Three splits		Four splits		Mean		Two years' mean
	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	
2.5	1.42	2.53	1.50	2.73	1.69	2.86	1.53	2.71	2.12
3.0	1.59	3.03	1.77	3.10	2.07	3.20	1.81	3.11	2.46
3.5	2.07	3.30	2.22	3.40	2.40	3.56	2.23	3.42	2.82
4.0	2.16	3.63	2.38	3.73	2.66	3.80	2.40	3.72	3.06
Mean	1.81	3.12	1.97	3.24	2.20	3.35			
Two years' mean	2.47		2.61		2.78				
CD (P = 0.05)									
MOP rate	0.11	0.03							
Split doses	0.10	0.03							

$tree^{-1}$ $year^{-1}$; decline in the fruit N content started thereafter, dropping to 0.231% under 4.0 kg MOP $tree^{-1}$ $year^{-1}$. Application of MOP in splits had a significant effect on the fruit N content. Maximum fruit N content of 0.284% was observed in trees receiving MOP in three splits which was statistically at par with four splits (0.278%). Lowest fruit N content of 0.276% was recorded in the trees receiving MOP in just two splits (**Table 9**). This is attributed to the existence of antagonistic relationship between N and K. There is a competition between K^+ and NO_3^- ions for their absorption by the apple trees (Divakar et al., 1984).

Phosphorus Content

Effect of different MOP treatments on leaf P content was statistically non-significant. Hence results are not presented. Effects on fruit P content were significant. Highest P content of 0.072% was found in the fruits harvested from trees receiving 2.5 kg MOP $tree^{-1}$ $year^{-1}$ and the lowest of 0.053% was recorded in the trees receiving 3.5 kg MOP $tree^{-1}$ $year^{-1}$ (**Table 10**). Among the split treatments, highest fruit P content of 0.067% was obtained where whole of MOP was applied in two splits.

Potassium Content

Potassium content in leaf (**Tables 11**) and fruit (**Tables 12**) exhibited continuous rise with increase in the rates of MOP application. Highest K content in leaf (3.06%) and fruit (0.334%) was recorded in the trees fertilized with 4.0 kg MOP $tree^{-1}$ $year^{-1}$ and it was minimum in leaf (2.12%) and fruit (0.249%) in the trees receiving 2.5 kg MOP $tree^{-1}$ $year^{-1}$.

Calcium Content

As shown in **Tables 13**, significant drop in the leaf Ca content occurred with increment of MOP dose from 2.5 kg $tree^{-1}$ $year^{-1}$ to 3.0 kg $tree^{-1}$ $year^{-1}$. With application of MOP, activity of K^+ ions in soil solution increases and is accompanied by simultaneous decrease in activity of Ca^{2+} ions, leading to the reduced absorption of Ca^{2+} by plant roots. Result is the decrease in Ca^{2+} uptake (Oberly and Kenworthy, 1961). Higher decrease in Ca was observed in the leaves of trees fertilized with 4.0 kg MOP $tree^{-1}$ $year^{-1}$ followed by 3.5 kg MOP $tree^{-1}$ $year^{-1}$. Similar results were also reported by

Table 12. Influence of fertilizer potassium on fruit potassium content (%) of Red Delicious

Rate of MOP (kg $tree^{-1}$)	Two splits		Three splits		Four splits		Mean		Two years' mean
	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	
2.5	0.28	0.18	0.29	0.22	0.31	0.22	0.29	0.21	0.25
3.0	0.34	0.19	0.35	0.20	0.34	0.24	0.34	0.21	0.28
3.5	0.40	0.24	0.42	0.25	0.43	0.23	0.42	0.24	0.33
4.0	0.43	0.24	0.44	0.24	0.46	0.21	0.44	0.23	0.33
Mean	0.36	0.22	0.38	0.23	0.38	0.23			
Two years' mean	0.29		0.30		0.30				
CD (P = 0.05)									
MOP rate	0.02	0.02							
Split doses	N.S	0.03							

Table 13. Influence of fertilizer potassium on leaf calcium content (%) of Red Delicious

Rate of MOP (kg tree^{-1})	Two splits		Three splits		Four splits		Mean		Two years' mean
	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	
2.5	1.64	2.20	1.85	2.21	1.99	2.32	1.83	2.24	2.04
3.0	1.99	2.20	1.84	2.47	1.92	2.59	1.91	2.42	2.17
3.5	1.82	2.20	1.76	2.41	1.65	2.40	1.74	2.34	2.03
4.0	1.81	2.00	1.87	2.10	2.00	2.16	1.89	2.09	1.99
Mean	1.81	2.15	1.83	2.30	1.89	2.37			
Two years' mean	1.98		2.07		2.13				
CD (P = 0.05)									
MOP rate	0.11	0.07							
Split doses	N.S	0.06							

Table 14. Influence of fertilizer potassium on leaf area (cm^2) of Red Delicious

Rate of MOP (kg tree^{-1})	Two splits		Three splits		Four splits		Mean		Two years' mean
	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	
2.5	14.13	11.21	14.34	12.32	16.27	14.37	14.91	12.63	13.77
3.0	17.92	15.38	17.77	15.77	19.41	17.11	18.37	16.09	17.23
3.5	20.98	14.58	23.63	15.63	24.22	15.43	22.94	15.21	19.08
4.0	22.25	16.35	22.68	16.50	23.23	17.11	22.79	16.65	19.72
Mean	18.82	14.38	19.61	15.06	20.83	16.01			
Two years' mean	16.60		17.34		18.42				
CD (P = 0.05)									
MOP rate	0.53	0.61							
Split doses	0.46	0.32							

Dev et al. (1995) and Dias and Flore (2002) for apple vegetation.

Leaf Area

There occurred a significant increase in the leaf area with increase in dose of MOP from 2.5 kg MOP tree^{-1} year^{-1} to 3.5 kg MOP tree^{-1} year^{-1} (**Table 14**). Highest mean leaf area was, however, noticed in the trees receiving 4.0 kg MOP tree^{-1} year^{-1}. Increase in the photosynthetic and other physiological activities associated with increasing K levels might have been responsible for the leaf expansion and resultant higher leaf area.

Conclusions

It is vividly concluded that the application of 2.5 to 3.0 kg MOP tree^{-1} year^{-1} is optimum for harvesting quality apple fruits. Application of doses in four splits further enhances the fruit quality.

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