AATCC Review

06 July 2025: Received
25 August 2025: Revised
03 September 2025: Accepted
01 October 2025: Available Online

https://aatcc.peerjournals.net/

Original Research Article

Open Access

Assessment of alfalfa (*Medicago sativa*) fodder quality under IW/CPE ratios, sowing methods and phosphorus levels in South Saurashtra region of Gujarat, India

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ABSTRACT

Irrigation and fertilization play the most important roles in producing hygienic fodder of Alfalfa (Medicago sativa L.). This study investigates the effects of irrigation, sowing technique, and phosphorus on the quality of alfalfa fodder. The two-year experiment was conducted in a split-plot design with three replications. The study focused on scheduling irrigation based on the IW/CPE ratio (0.6, 0.8, and 1.0), sowing techniques (line sowing and broadcasting), and phosphorus levels (30, 50, 70, and 90 kg P_2O_5 ha^{-1} through SSP). The 0.6 IW/CPE ratio irrigation schedule recorded significantly higher RFV (%) and crude protein content. Significantly higher NDF and ADF (%) were recorded with the 1.0 IW/CPE ratio irrigation schedule. Phosphorus content had a significant effect on the quality parameters of the fodder. The application of 70 and 90 kg P_2O_5 ha^{-1} wasfound to be at par with each other during both years as well as in the pooled results. The maximum RFV value was found with the 30 kg P_2O_5 ha^{-1} application. Regression analysis revealed a linear and negative association between RFV value and crude protein content and a linear and positive association between NDF and ADF. Maintaining an irrigation schedule of a 1.0 IW/CPE ratio consistently leads to enhanced alfalfa crude protein yield and fiber content, especially when assured irrigation water is available. Scarcity of water is major challenge during this time and use of phosphoorus fertilizer application in case per unit quantity has major importance in the legume based fodder crops. So that; this study will bring awareness about the production and productivity of fodder and better management of irrigation and phosphorus in this areas as we as other part of the country. Better use of natural resources (water) and agricultural inputs (phosphorus fertilizer) can ameliorate the effects of seasonality and improve the quality and productivity of alfalfa fodder in livestock production systems.

Keywords: *Irrigation, IW/CPE Ratio, forage, quality, sowing technique, nutrient and Phosphorus.*

Introduction

With 15 per cent of the total cattle population and 16 per cent of total human population, it is inevitable for a country like India to focus on its forage need and quality. Global population growth has coincided with increases in agricultural and industrial activities aiming to focus on food needs. Due to ever-increasing demand of human population and an apparent danger on the food security, arable land is mainly used for food and cash crops which means that there is little chance of having good quality arable land available for fodder production. The area under cultivated fodders in India is estimated to be 4.5 per cent of the total cultivated area *i.e.* 8.4 M ha as against the suggested allocation of at least 10 per cent of the cultivated area i.e., 14.7 M ha (20). Lucerne (Alfalfa) seems to be a promising forage crop. It is an important fodder crop in the plains of India and all around the world.

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DOI: https://doi.org/10.21276/AATCCReview.2025.13.04.636

Also, the crop has been cultivated for centuries and remains widely used by farmers in traditional agro-ecosystems (12). It is a C_3 plant and one of the most important perennial legume forage around the globe as it has good nutritional forage quality for livestock husbandry and its unbeatable competence to improve soil fertility (15, 9).

Alfalfa also known as 'green gold' and 'queen' of cultivated fodder crops, it occupies third position in area and production after fodder sorghum and hybrid Napier in India. It is richly proteinaceous (16-25 per cent), perennial legume with wide adaptability throughout the world. It gives higher yield due to its multicut nature, good regeneration after cuttings and long period of fodder supply. The crop can be raised in different regions of the country with rainfall ranging from 450 to 950 mm and on different soil types ranging from sandy loam to medium black. Lucerne is cultivated over an area of 3.5 M ha in the world with an average green fodder yield of 50 -125 t/ha/year with 8-12 cuttings. Whereas in India, it occupies an area of one M ha and provides 60 t to 130 t of green forage/ha. It is grown as a farm crop in Punjab (13554 acres), western districts of Uttar Pradesh, Maharashtra (18400 acres), Gujarat (19900 acres), Madras and West Bengal (32). Forage nutritive value can be affected by many factors, including development stage at harvest, climate

(i.e., high temperature and drought), soil fertility and carbon dioxide level (3). Forage nutritive value of alfalfa is usually higher with water stress than without water stress (29, 17). However, it is generally accepted that alfalfa is a high water required crop as compared with other crops due to its high yield and long growing season (4). Studies have indicated that the seasonal evapotranspiration of alfalfa is approximately 700–1600 mm depending on the climate and growing period (31 and 11). In case of fertilizers, peoples are more concern only about the use of nitrogen fertilizers; very few farmers have knowledge about the use of phosphorus fertilizers. Application of phosphorus fertilizer is also essential for crops (2). Influence of phosphorus fertilization on agronomic performance of alfalfa has been well documented by various researchers (27; 30). A proper P nutrition is essential for alfalfa plant survival, and its supply is often necessary to reach maximum stand development, productivity, and persistence (5-6). Phosphorus is involved in the nitrogen fixation since it contributes to increase the size and number of Rhizobia nodules (25).

Research investigating the effects of IW/CPE ratio, sowing technique and phosphorus on the agronomic performance of alfalfa suggests that the interactions between irrigation and nutrient should not be underestimated. This study uniquely adds to the database of information on alfalfa nutritive value by reporting results across a complete range of IW/CPE ratio from fully irrigated to deficit irrigation for a complete two-year study of experimentation. The objectives of this study were to evaluate the effects of different irrigation amounts Sowing techniques and Phosphorus on forage nutritive values, i.e., crude protein (CP), acid detergent fiber (ADF),neutral detergent fiber (NDF), Ash content, and relative feed value (RFV) for a two-year field study of alfalfa in South Saurashtra region of Gujarat India.

MATERIAL AND METHOD

Experimental Site:

The present investigation was carried out at 'Farming System Research Station, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat (India) during winter cycle (*Rabi* season) 2021-22 and 2022-23. The farm is geographically situated at an altitude of 60 m above sea level on 21.5^0 N latitude and 70.5^0 E longitude. The rainy season commences in the second fortnight of June and ends in September with an average rainfall of 1088.55 mm. Soil at the site was clay soil classified as medium black soil. Primal chemical properties of the soil (0-30 cm) were as follows: pH, 7.8; nitrogen, 256 kg ha^{-1}; available phosphorus, 29.73 kg ha^{-1}; and available potassium, 212 kg ha^{-1}; available Sulphur 9.61 mg kg^{-1} organic matter 0.67 per cent. The climatic features of the study site during the experimental years are presented in Table 1.

Experimental Design:

The experiment was conducted using a split plot design. In main plot two factors were there, first is irrigation levels (I_1: 0.6 IW/CPE ratio, I_2: 0.8 IW/CPE ratio and I_3: 1.0 IW/CPE ratio)and sowing technique (M_1: Line sowing at 25 cm and M_2: Broadcast) and in sub-plot four phosphorus levels (P_1: 30 kg P_2O_5 ha^{-1}, P_2: 50 kg P_2O_5 ha^{-1}, P_3: 70 kg P_2O_5 ha^{-1} and P_4: 90 kg P_2O_5 ha^{-1} with Single super phosphate). Total treatments were 24 (No. of total plot 72). The combinations of treatments werereplicated thrice in a 20 m^2 plot area (5×4 m).

Plant materials:

The variety of alfalfa,Anand Lucerne-2 was sown in this experiment. Single super phosphate was used for phosphorus and urea and murate of potash were applied for nitrogen and potash.

Sampling and analysis:

Alfalfa was harvested at the early flowering stage (10 % blooming), and a total of four cuts were done in each year. At each harvest, three representative quadrant samples (1 m × 1 m) were randomly selected at the center of each plot and clipped to a height of about 5 cm for measuring alfalfa forage yield. Forage dry biomass was determined after oven-drying the samples at 60 °C until they reached a constant weight (10). Dried plant samples were ground into fine powder to pass through a 0.04-inch screen and used for nutritive analyses. Total N contents were determined by the standard Kjeldahl method and crude protein contents (CP, %) was estimated as N% × 6.25 (13). Neutral detergent fiber (NDF, %) and acid detergent fiber (ADF, %) were determined using ANKOM 2000 Automated Fiber Analyzer (33). Total ash content was estimated by the fibretherm method (1).

$$\text{Fiber content (\%)} = \frac{Wr - Wa}{Wd} \times 100$$

$$\text{Ash content (\%)} = \frac{Wa}{Wd} \times 100$$

Where,

Wr = Weight of dried residue

Wa = Weight of ash

Wd = Weight of dried samples

Relative feed value (RFV) was calculated from dry matter digestibility (DMD) and dry matter intake (DMI) using ADF (%) and NDF (%), respectively (13):

$$\text{RFV (\%)} = \frac{\text{DMI} \times \text{DMD}}{1.29}$$

$$\text{DMI (\%)} = \frac{120}{\text{NDF (\% DM) (2)}}$$

$$\text{DMD (\%)} = 88{\cdot}9 - 0.779 \times \text{ADF (\% DM)}$$

Statistical analyses

Statistical analysis was performed using SPSS software, which was installed in the Department of Statistics at Junagadh Agricultural University, Junagadh.

Table 1: Weather data of the experiment area (Average of 2021-22 and 2022-23)

Month	Temperature		Humidity (%)	Wind speed (m/s)	BSS (hrs.)	Rainfall (mm)	ET (mm/day)	Rad (MJ/m^2/day)	ETo
	Min.	Max.							
Jan	11.43	27.75	54.31	1.3	6.7	0.1	4.3	16.6	3.11
Feb	14.18	32.01	49.71	1.1	8.9	0	5.4	19.2	3.84
March	20.17	38.00	38.64	1.4	9.6	0	8.3	22.4	5.57
April	23.23	40.76	46.03	1.5	9.3	4.8	8.8	23.5	6.42
May	25.82	38.76	56.92	2.4	7.6	26.55	8.8	21.4	6.65
June	26.33	36.70	67.66	2.4	4.2	92.65	6.8	16.2	5.21
July	24.77	31.51	82.78	2.3	1.6	461.25	3.0	12.3	3.34
August	24.02	31.71	80.10	1.9	2.4	213.45	3.2	13.2	3.43
September	23.80	31.38	81.48	1.3	4.0	480.15	3.0	14.7	3.39
October	21.60	34.40	59.07	0.9	8.6	64.4	4.4	19.4	4.26
November	16.71	33.61	49.88	0.8	7.9	0	4.3	16.4	3.47
December	15.11	29.87	52.80	1.1	6.8	0	4.3	14.1	3.13

RESULTS AND DISCUSSION

Effect of irrigation, sowing method and levels of phosphorus on ash content and RFV value of fodder alfalfa

The data indicated in Table 2, showing that the irrigation had not significant effect on the ash content of the alfalfa during 2021-22 and 2022-23. On the basis of pooled results, it has been recorded significant results. However, IW/CPE ratio 0.6 obtained numerically higher ash content as compared to the 0.8 and 1.0 IW/CPE ratios but it was not statistically differ to IW/CPE ratio IW/CPE 0.6. Sowing method did not have significant effect on ash content of the alfalfa fodder during both the years of experimentation and pooled results of the two years. Application of phosphorus fertilization had significant effect on ash content. Application of 70 kg P_2O_5/ha recorded significantly higher ash content as compared to 30 and 50 kg P_2O_5/ha but it was obtained comparable to the application of 90 kg P_2O_5/ha during both the years of experiment and pooled results of two years.

Significantly maximum amount of RFV value was found with the irrigation scheduled at 0.6 than 1.0 IW/CPE ratio during both the years of study. This treatment was found being at par with the 0.8 IW/CPE ratio during both year of study. On the base of pooled results, irrigation scheduled 0.6 IW/CPE ratio was found significantly higher RFV value than 0.6 and 0.8 IW/CPE ratios. Sowing did not have any significant effect on the RFV value of fodder alfalfa during both the years of study and in pooled result of over the year. Phosphorus application had a significant effect on the RFV value of the fodder value of the alfalfa. Application of 70 and 90 kg P_2O_5/ha were found to beat par to each other during both the years of study as well as on the basis ofpooled results. The maximum value of RFV was found with the 30 kg P_2O_5/ha during both the years, as well as in pooled result of over the years. The RFV was significantly affected by irrigation level (Table 2). The RFV were higher for the 0.6 IW/CPE ratio level than for the other two irrigation levels for all four cuttings, which indicates that water stress could improve the quality of alfalfa. The yield decreased with increased water stress, but the alfalfa quality increased because drought delayed maturation and increased the leaf-stem weight ratio (18). Alfalfa with a high leaf to stem ratio has lower RFV. The RFV increased dramatically with successive harvests (Table 2). Higher rate of phosphorus also reduces the RFV value of the alfalfa because phosphorus increases the nodule formation that nodule increases in the nitrogen fixation (8) but phosphorus could also increase the maturity of the plant. Decreasing the RFV of the alfalfa by P fertilizing might be explained by the P-induced maturity of alfalfa. Besides, P fertilizer could decrease the plant density of alfalfa and structural carbohydrate content increases under lower densities, which in turn decreases the RFV (7).

Table 2: Ash content and RFV (%) of Lucerne influenced by IW/CPE ratio, sowing method and levels of phosphorus

Treatment	Ash content (%)			RFV (%)		
	Average		Pooled	Average		Pooled
IW/CPE ratio (a)	2021-22	2022-23		2021-22	2022-23	
I_1: 0.6 IW/CPE	12.90	12.87	12.89	328.38^{a}	305.99^{a}	317.18
I_2: 0.8 IW/CPE	12.59	12.73	12.66	307.36^{ab}	287.00^{b}	297.18
I_3: 1.0 IW/CPE	12.49	12.63	12.56	290.12^{b}	271.84^{b}	280.98
S.Em. ±	0.12	0.09	0.07	7.34	5.37	4.546
C.D. (P=0.05)	NS	NS	0.22	23.12	16.92	13.41
Sowing method (b)						
M_1: Line sowing at 25 cm	12.64	12.75	12.70	306.39^{NS}	286.65^{NS}	296.52
M_2: Broadcast	12.68	12.74	12.71	310.85^{NS}	289.90^{NS}	300.37
S.Em. ±	0.10	0.07	0.06	5.99	4.38	3.712
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS
Phosphorus level (kg/ha)						
P_1: 30 kg P_2O_5/ha	12.48^{c}	12.54^{c}	12.51	324.45^{a}	300.81^{a}	312.63
P_2: 50 kg P_2O_5/ha	12.64^{b}	12.75^{b}	12.69	311.28^{b}	291.63^{b}	301.46
P_3: 70 kg P_2O_5/ha	12.75^{a}	12.84^{a}	12.79	299.44^{c}	280.39^{c}	289.92
P_4: 90 kg P_2O_5/ha	12.77^{a}	12.86^{a}	12.81	299.30^{c}	280.26^{c}	289.78
S.Em. ±	0.02	0.03	0.02	2.59	1.36	1.464
C.D. (P=0.05)	0.08	0.08	0.06	7.43	3.91	4.13
I×M×P interaction						
S.Em. ±	NS	NS	NS	6.35	3.34	NS
C.D. (P=0.05)				18.20	9.58	

(I-Irrigation, M- Sowing method, and P- Levels of phosphorus)

Effect of irrigation, sowing method and levels of phosphorus on NDF and ADF value of fodder alfalfa

The data of Table 3 are showing that the irrigation scheduling has favorable effect on the NDF and ADF value of alfalfa fodder. Irrigation scheduled at 1.0 IW/CPE ratio has been obtained significantly higher NDF and ADF value than the 0.6 IW/CPE ratio. However. It was found being at par with the 0.8 IW/CPE ratio during 2021-22 and 2022-23. On the based of pooled results, it was found significantly higher with the irrigation scheduled 1.0 IW/CPE ratio. It might be due to more irrigation or optimum irrigation beneficial for the growth and development of the plant. It increases in the plant height, no. of tiller and leaf of the plant. That is why optimum or more irrigation increases in the fiber content of the fodder crop. Sowing method had not any significant effect on the NDF and ADF value of alfalfa during both the years of study and as well as polled results of two years. Phosphorus fertilization had significant effect on the NDF and ADF values of the alfalfa fodder. Application of 70 and 90 kg P_2O_5/ha resulted found comparable result to each other and significantly higher than 30 and 50 kg P_2O_5/ha during both the years of study. Based on pooled results of two years, it has been obtained significant with 70 and 90 kg P_2O_5/ha. Phosphorus increases in the root formation and nitrogen fixation in the leguminous crops and it is source of energy formation in the plant. That is why phosphorus plays a significant role in the growth and development of the plant. Greater irrigation amounts have the potential to elevate NDF and ADF value, provided an adequate nitrogen supply exists (18). The influence of phosphorus fertilizer rate on NDF and ADF values were observed to be modest. Research has highlighted the capability of phosphorus fertilization to enhance the fiber levels in alfalfa (35). In our study, it became evident that the rise in fiber content ceased upon reaching the application rate of 70 kg P_2O_5/ha (Table 3). This aligns with the findings (23), who also noted a reduction in fiber content when the fertilizer application exceeded 50 kg P_2O_5/ha.

Table 3: NDF and ADF (%) of lucerne influenced by IW/CPE ratio, sowing method, and levels of phosphorus

Treatment	Fibre content (%)					
	NDF (%)			ADF (%)		
	Average		Pooled	Average		Pooled
IW/CPE ratio (a)	2021-22	2022-23		2021-22	2022-23	
I_1: 0.6 IW/CPE	21.47[b]	22.74[b]	22.10	17.43[b]	18.46	17.95
I_2: 0.8 IW/CPE	22.54[ab]	23.84[ab]	23.19	18.98[a]	20.10	19.54
I_3: 1.0 IW/CPE	23.69[a]	24.92[a]	24.31	19.69[a]	20.89	20.29
S.Em. ±	0.42	0.35	0.27	0.42	0.35	0.273
C.D. (P=0.05)	1.32	1.11	0.81	1.32	1.11	0.81
Sowing method (b)						
M_1: Line sowing at 25 cm	22.64	23.91	23.27	18.91	19.89	19.40
M_2: Broadcast	22.50	23.75	23.13	18.49	19.75	19.12
S.Em. ±	0.34	0.29	0.22	0.34	0.29	0.223
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS
Phosphorus level (kg/ha)						
P_1: 30 kg P_2O_5/ha	21.61[c]	22.97[c]	22.29	18.13[b]	19.32	18.72
P_2: 50 kg P_2O_5/ha	22.38[b]	23.59[b]	22.98	18.53[b]	19.61	19.07
P_3: 70 kg P_2O_5/ha	23.14[a]	24.40[a]	23.77	19.09[a]	20.17	19.63
P_4: 90 kg P_2O_5/ha	23.14[a]	24.38[a]	23.76	19.06[a]	20.18	19.62
S.Em. ±	0.16	0.09	0.09	0.16	0.09	0.092
C.D. (P=0.05)	0.46	0.27	0.26	0.46	0.27	0.26
I×M×P interaction						
S.Em. ±	0.39	0.54	NS	0.39	0.23	NS
C.D. (P=0.05)	1.12	1.54		1.12	0.66	

(I-Irrigation, M- Sowing method, and P- Levels of phosphorus)

Effect of irrigation, sowing method and levels of phosphorus on protein contentand yield

Data presented in Table 4 that distinctly reveals the highest crude protein content was achieved when irrigation was scheduled at a 0.6 IW/CPE ratio across both the years of the study. This consistent trend was also observed when analyzing the combined results over the two years. Notably, IW/CPE ratios of 0.8 and 1.0 yielded fairly comparable outcomes in both individual years and the combined results. Deficit irrigation appeared to enhance the rate of nutrient assimilation within the plants and promote increased nutrient conversion due to limited moisture supply. These findings are in line with earlier studies, (19), which indicated that a rise in water scarcity corresponds to an increase in CP percentage (26, 28), similarly noted an augmentation of CP content under water stress and impact of intensified water stress severity. The sowing method did not yield the desired outcomes in terms of crude protein content over the two years under investigation. This could be attributed to the nearly identical plant population, resulting in minimal competition during that period. Consequently, the absence of competitive pressure within the population density might have contributed to the inability to demonstrate a noteworthy impact on the essential parameters of fodder alfalfa. Phosphorus application had significant effect on the crude protein content of the alfalfa. Application of phosphorus fertilization 70 and 90 kg P_2O_5/ha has been given comparable results to each other, and it was found at par to each other during both the study as well as pooled result of two years. Significantly lowest crude protein content was recorded with the application of 30 kg P_2O_5/ha during both years of study.

Significantly elevated crude protein yield was observed when irrigation was set at a 1.0 IW/CPE ratio during both study years. This consistent trend persisted in the pooled results over the two years. In contrast, the chosen sowing method did not yield a noteworthy effect on the crude protein yield of the alfalfa. Notably, phosphorus application demonstrated a positive impact on crude protein yield. Specifically, applying 70 and 90 kg P_2O_5/ha resulted in nearly identical outcomes, which were also comparable to each other. Conversely, the application of 30 kg P_2O_5/ha led to significantly lower crude protein yield during both study years and when considering the pooled results. The crude protein yield is intricately linked to the dry fodder yield of the crop. Employing an irrigation schedule of 1.0 IW/CPE ratio generated notably higher dry fodder yields compared to ratios

of 0.6 and 0.8 IW/CPE. Similarly, the application of 70 and 90 kg P_2O_5/ha resulted in almost equivalent dry fodder yields, thereby contributing to the higher production of crude protein content throughout both study years.

Table 4: Crude protein content (%) and yield (q ha^{-1}) of lucerne influenced by IW/CPE ratio, sowing method, and levels of phosphorus during 2021-22, 2022-23, and pooled

Treatment	Crude protein content (%)			Crude protein yield (q ha^{-1})		
	Average		Pooled	Average		Pooled
IW/CPE ratio (a)	2021-22	2022-23		2021-22	2022-23	
I_1: 0.6 IW/CPE	18.19	18.50	18.35	4.82	5.17	4.99
I_2: 0.8 IW/CPE	17.87	18.17	18.02	7.94	8.52	8.23
I_3: 1.0 IW/CPE	17.69	18.00	17.84	8.43	9.04	8.73
S.Em. ±	0.04	0.07	0.04	0.15	0.14	0.10
C.D. (P=0.05)	0.14	0.21	0.12	0.47	0.43	0.30
Sowing method (b)						
M_1: Line sowing at 25 cm	17.94	18.25	18.09	7.14	7.66	7.40
M_2: Broadcast	17.90	18.20	18.05	6.98	7.49	7.23
S.Em. ±	0.04	0.05	0.03	0.12	0.11	0.08
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS
Phosphorus level (kg/ha)						
P_1: 30 kg P_2O_5/ha	17.66	17.96	17.81	5.16	5.54	5.35
P_2: 50 kg P_2O_5/ha	17.86	18.16	18.01	6.53	7.00	6.76
P_3: 70 kg P_2O_5/ha	18.08	18.39	18.23	8.31	8.91	8.61
P_4: 90 kg P_2O_5/ha	18.08	18.39	18.23	8.24	8.85	8.55
S.Em. ±	0.03	0.05	0.03	0.10	0.11	0.07
C.D. (P=0.05)	0.08	0.13	0.08	0.28	0.30	0.20
I×M×P interaction						
S.Em. ±	NS	NS	NS	0.24	0.26	NS
C.D. (P=0.05)				0.68	0.75	

(Irrigation, M- Sowing method, and P- Levels of phosphorus)

Relationship of measured indexes, irrigation, and Phosphorus treatments

The regression analysis revealed a linear and negative association between RFV value (R^2 = 0.99) and crude protein content (R^2 = 0.97), and a linear and positive association between NDF (R^2 = 0.99) and ADF (R^2 = 0.95). Additionally, ADF and NDF contents showed positive correlations with phosphorus rates, with determination coefficients (R^2) of 0.89 for both. In contrast, RFV and CP content exhibited a linear and negative association with phosphorus rates, with R^2 values of 0.89 for both. Crude protein content (CP), relative feed values (RFV), neutral detergent fiber (NDF), and acid detergent fiber (ADF) directly reflect the nutritional quality of forages (16). In the present study, NDF and ADF increased with an increasing IW/CPE ratio from 0.6 to 1.0, while RFV and CP content decreased. The decline in forage quality was associated with reduced CP contents and increased ADF and NDF contents at the highest irrigation amount. Higher irrigation reportedly increases the stem-to-leaf ratio and accelerates crop maturity, contributing to decreased CP contents and increased stem fiber contents (24).Among phosphorus treatments, forage nutritive quality was optimal at 70 kg P_2O_5 ha^{-1}. Adequate phosphorus fertilization improves forage biomass by regulating the leaf-to-stem ratio, leading to enhanced overall forage nutritive values (16). Appropriate phosphorus application has been reported to improve soil phosphorus supply capacity (10), stimulate root growth (21), stimulate soil microbial biomass and enzyme activities, and increase N_2 fixation (14). However, our results revealed a negative impact of high phosphorus rates on the nutritive indices of alfalfa. CP contents and RFV were lowest, while ADF and NDF contents were highest, at the 70 kg P_2O_5 ha^{-1} application. The decrease in CP contents and RFV value with higher phosphorus application could be attributed to reduced transport efficiency rates of resources (34). Another possible reason for lower forage quality with high irrigation and phosphorus application is their interactive impact on increasing cell wall components and fiber quantities, as evidenced by higher ADF and NDF contents in our study. This relationship has been previously reported in various forage crops (24).

Conclusion

The findings of the current study suggest that maintaining an irrigation schedule of 1.0 IW/CPE ratio consistently leads to enhanced alfalfa crude protein yield and fiber content, especially when assured irrigation water is available. However, in scenarios of limited water availability, adopting an irrigation ratio of 0.6 IW/CPE appears to yield higher crude protein content. Application of 70 kg P_2O_5/ha consistently resulted in elevated levels of fiber, crude protein, ash content, and crude protein yield over the entire study duration. The sowing method, on the other hand, did not demonstrate any significant impact on the quality parameters of alfalfa fodder.

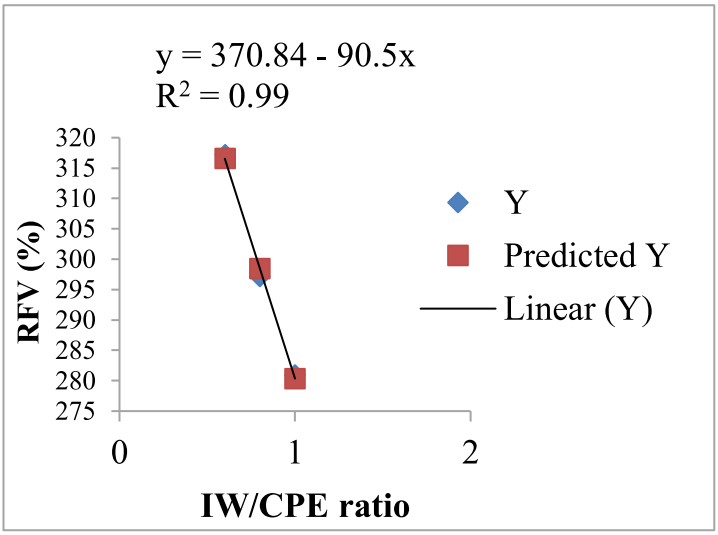
Future aspect of study

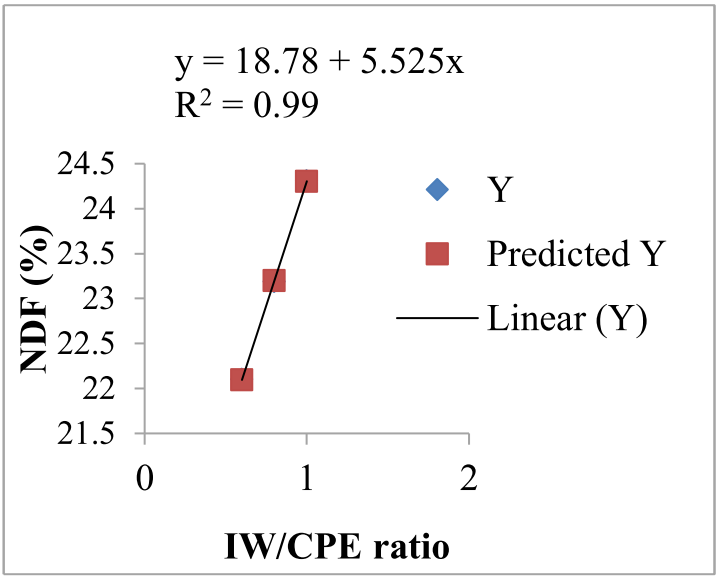
This study has been conducted in the view point of changing climate scenario and raising demand of fodder for cattles because day by day population is rising their footprints towards alarming tune. In this case; water and nutrients management are most important things for the increasing of fodder yield. This study will definitely enhance and secure future demand of fodder under water scarcity and knowledge of nutrient management.

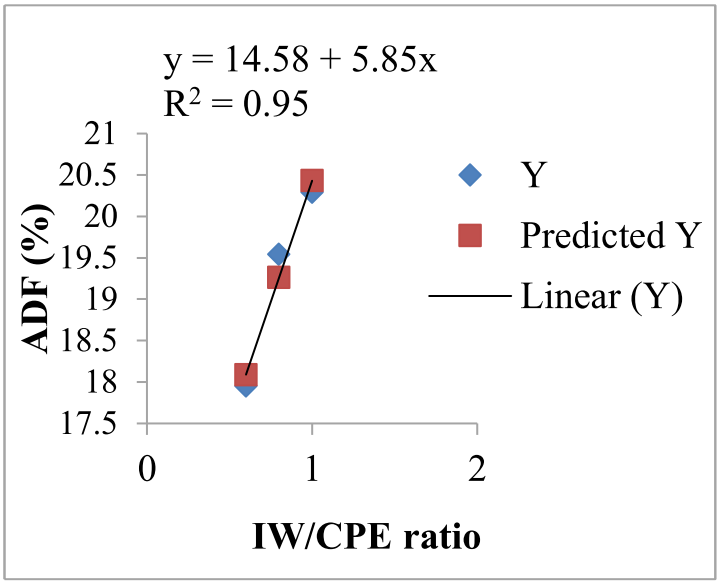
Acknowledgements: We would like to thank to the Department of Agronomy, Junagadh Agricultural University, Junagadh, Gujarat, India for supporting during my research work.

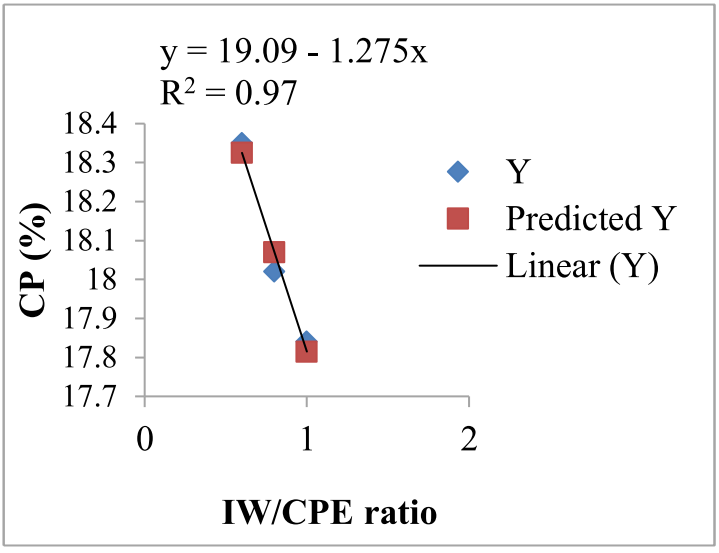
Conflict of interest: The authors declare no conflict of interest.

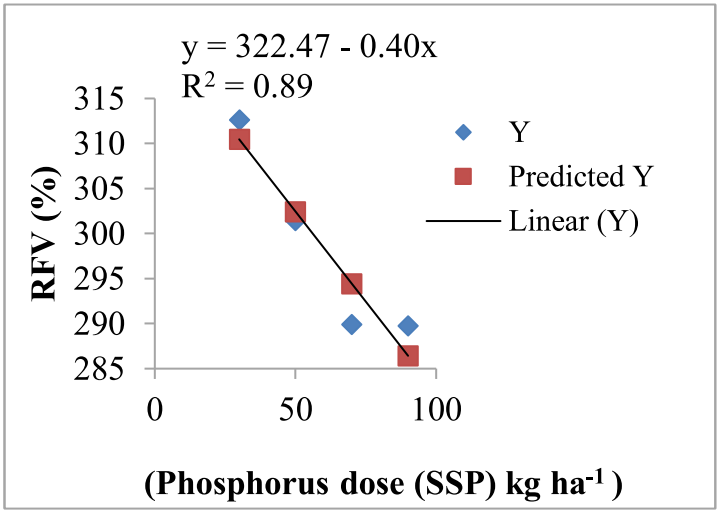
Funding: There is no funding provided by anyone

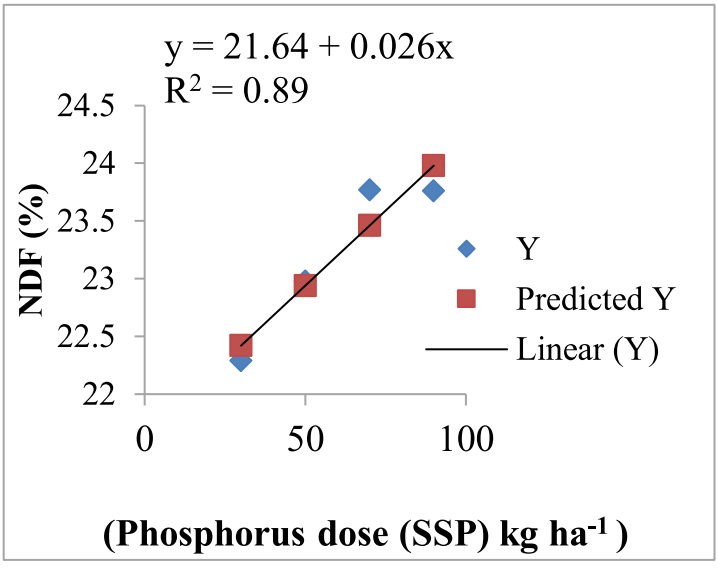


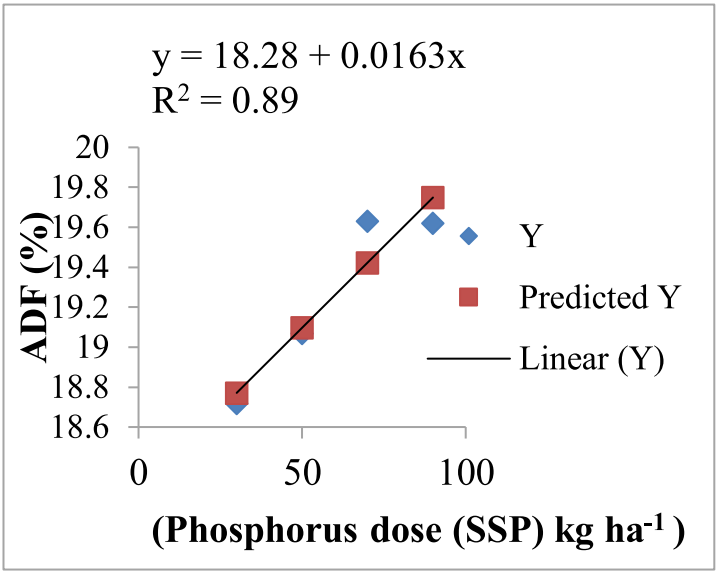












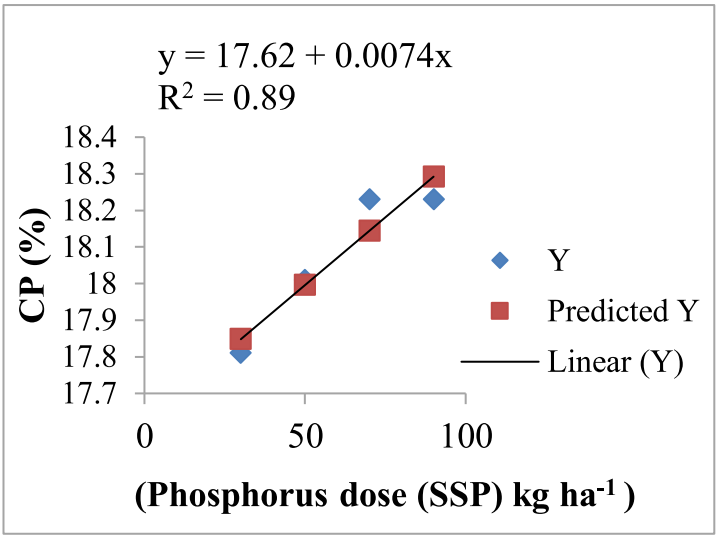


Fig. 1: Relationship of crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF) and relative feed value (RFV) with irrigation and phosphorus treatments

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