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Influence of Weed Control Measures and Nutrient Management on Nutrient Content, Uptake and Nutrient use Efficiency of Fennel Crop (*Foeniculum vulgare* Mill.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A research experiment was conducted during the *Rabi* season of 2021-22 at the College of Agriculture, SKRAU, Bikaner. The objective of the experiment was to evaluate the influence of different nutrient management and weed control treatments on the nutrient content, uptake and nutrient use efficiency of fennel crop. The experiment consisted of sixteen treatment combinations, which included four nutrient management treatments and four weed control measures. The nutrient management treatments included control (no fertilizer applied), 75 % RDF, 100 % RDF and 125 % RDF and four weed control measures- weed free, pendimethalin @ 0.75 kg ha^{-1} (PE), oxyfluorfen @ 50g ha^{-1} (POE at 25 DAS) and weedy check. These treatments were replicated three times in a factorial randomized block design (FRBD), ensuring the reliability and accuracy of the results. The weed-free treatment was found to be significantly better in increasing the nitrogen, phosphorus, and potassium content in both the seed and straw of the crop. Additionally, the weed-free treatment also resulted in higher nutrient uptake by the crop compared to the weedy check treatment. Among the nutrient management treatments, the application of 100% RDF showed the most promising results. It improved the nutrient content in both the seed and straw of the crop and recorded the highest nutrient use efficiency. This efficiency was found to be at par with the application of 125% RDF and significantly higher than the remaining treatments. Overall, the experiment demonstrated the importance of weed control and proper nutrient management in enhancing the nutrient content and uptake by the crop. The weed-free treatment and the application of 100% RDF were identified as the most effective strategies in achieving these goals. These findings can be valuable for farmers and agricultural practitioners in optimizing crop productivity and ensuring sustainable agricultural practices.

Keywords: Weed control measures; nutrient management; uptake; content; nutrient use efficiency; fennel; RDF.

1. INTRODUCTION

Fennel, also known as Saunf, is a highly important seed spice crop that belongs to the Umbelliferae (Apiaceae) family. It is believed to have originated in the Mediterranean and Southern Europe. The fennel plant has a pleasant aroma and its all parts, including leaves, stalks, and seeds, are edible. Fennel seeds are known for their fragrant scent and aromatic flavor, which is due to the presence of volatile oils like Anethole and Fenchone. These seeds are commonly used in various culinary preparations, such as meals, meat and fish dishes, ice cream, alcoholic beverages, and herb blends. They are also frequently used in the making of candies, soups, sauces, pastries, pickles, liquors, and bakery dishes. The seeds have approximately 9.5% protein, 10.0% fat, 42.3% carbohydrates, 18.5% fiber, and 13.4% minerals. The amount of volatile oil in the seeds can range from 0.7% to 6.0%, depending on the specific genotypes or botanical types.

In India, fennel is mostly produced in Gujarat, Rajasthan, Madhya Pradesh, Maharashtra, Haryana, Uttar Pradesh, and Punjab. In Rajasthan fennel is cultivated on 26.25 thousand hectare area and produces 25.62 thousand tones with an average yield of 976 kg ha^{-1} (Spice Board, India, 2019-20). It is primarily grown in the districts of Tonk, Pali, Sirohi and Jodhpur and to a limited extent in Bharatpur, Bikaner, Kota, Jaipur and Ajmer.

Fennel is a valuable commercial cash crop traditionally grown as *rabi* season crop in dry and semi-arid areas. It is a slow growing plant that takes longer time to germinate and leads heavy weed infestation in the initial days of growth. Looking to the importance of the crop the average productivity is low, so the efforts have made to enhance the productivity of the fennel by the management of agronomic practices and fertilizer. Macro nutrients such as N, P and K are essential to all crops. Nitrogen is the most important element that limits crop growth and yield. Most of the nitrogen in plants is present in organic form: nucleic acid, hormones, membrane component, coenzymes and pigment. Phosphorus is an essential component of the genetic information system, the energy transfer compounds (ATP and other nuclei-proteins), cell membranes and phospho-proteins. Potassium improves drought tolerance and water uptake in plants. Hence, balanced crop nutrition and good weed control practices is a key factor to achieving higher crop yields. Keeping the above

facts in view, the study was conducted for knowing the suitable weed control measure and best nutrient management for maximizing nutrient content, uptake and nutrient use efficiency of fennel.

2. MATERIALS AND METHODS

A field experiment was conducted at Instructional farm, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner during *Rabi* season 2021-22 which is situated at 28.01^0 N latitude and 73.22^0 E longitude and altitude of 234.70 meters above mean sea level. The region falls in Agro-climatic zone IC (Hyper Arid Partially Irrigated North Western Plain Zone) of Rajasthan. The soil of experimental site was loamy sand having pH 8.5, low organic carbon (0.18%), low available N (121.4 kg ha^{-1}), medium P (19.08 kg ha^{-1}) and low K (191.42 kg ha^{-1}). The experiment was laid out in factorial randomized block design with three replications. The treatments comprising combinations of 16 treatments comprising four nutrient management treatments, viz. control (no fertilizer applied), 75 % RDF, 100 % RDF and 125 % RDF and four weed control measures, viz. weed free, pendimethalin @ 0.75 kg ha^{-1} (PE), oxyfluorfen @ 50g ha^{-1} (POE at 25 DAS) and weedy check. Fennel crop variety RF-143 was used as a test crop. Herbicides were sprayed by using knapsack sprayer at pre-emergence (PE) and post-emergence of both weed and crop. Urea, SSP and MOP were used as source of N, P and K, respectively. The nitrogen content was estimated by Nesssler's reagent colorimeter method [1], Phosphorus by Ammonium 'vanadomolybdatephosphate' yellow color method [2] and potassium by Flame photometer method [3]. The nutrient uptake was calculated from N, P and K content in seed and straw at harvest using following equation.

Nurient uptake (kg ha^{-1})=(Nutrient content in seed (%) X Seed yield + Nutrient content in straw (%) X Straw yield)/100

The nutrient use efficiency was computed by using the following formula:

NUE (kg kg^{-1})=Grain yield of fertilizer plot-Grain yield of unfertilized plot) / Quantity of applied nutrient

3. RESULTS AND DISCUSSION

3.1 Effect of Weed Control Measures

Nutrient content in seed and straw and their total uptake by crop were significantly influenced by different weed control measure. The lowest content of N, P and K in seed and straw was found in weedy check, whereas, maximum content of N, P and K was recorded in weed free treatment followed by pendimethalin @ 0.75 kg ha^{-1} (PE). Higher content of nutrients in crop ascribed great availability of nutrients in soil, and less weed population. It is clear from the data (Table 1-3), that minimum uptake of N, P and K was observed under weedy check. Data further revealed that weed free recorded the significantly highest uptake of 40.50 kg N, 10.72 kg P and 58 kg K ha^{-1}. Pendimethalin @ 0.75 kg ha^{-1}

Table 1. Effect of weed control measures and nutrient management on nitrogen content and uptake by crop

Treatment	Nitrogen Content (%)		Total N Uptake
	Seed	Straw	(Kg ha^{-1})
Nutrient management			
Control	1.19	0.562	21.79
75% RDF	1.31	0.611	29.19
100 % RDF	1.34	0.651	34.18
125 % RDF	1.35	0.653	35.56
SEm+	0.02	0.008	0.46
CD (p=0.05)	0.05	0.023	1.34
Weed control measures			
Weed free	1.39	0.672	40.50
Pendimethelin 750g ha^{-1}PE	1.33	0.630	32.57
Oxyfluorfan50g ha^{-1}PoE at 25 DAS	1.31	0.626	30.39
Weedy check	1.16	0.549	17.26
SEm+	0.02	0.008	0.46
CD (p=0.05)	0.05	0.023	1.34

Table 2. Effect of weed control measures and nutrient management on phosphorus content and uptake by crop

Treatment	Phosphorus Content (%)		Total P Uptake (Kg ha^{1})
	Seed	Straw	
Nutrient management			
Control	0.404	0.157	5.60
75% RDF	0.440	0.177	7.63
100 % RDF	0.464	0.190	9.11
125 % RDF	0.469	0.192	9.52
SEm+	0.006	0.002	0.14
CD (p=0.05)	0.018	0.007	0.42
Weed control measures			
Weed free	0.472	0.193	10.72
Pendimethalin 750g ha^{-1}PE	0.468	0.191	8.60
Oxyfluorfan50g ha^{-1}PoE at 25 DAS	0.444	0.179	8.03
Weedy check	0.393	0.152	4.52
SEm+	0.006	0.002	0.14
CD (p=0.05)	0.018	0.007	0.42

Table 3. Effect of weed control measures and nutrient management on potassium content and uptake by crop

Treatment	Potassium Content (%)		Total K Uptake (kg ha^{-1})
	Seed	Straw	
Nutrient management			
Control	0.520	1.38	30.02
75% RDF	0.587	1.54	41.43
100 % RDF	0.602	1.64	49.04
125 % RDF	0.608	1.66	51.22
SEm+	0.009	0.02	1.03
CD (p=0.05)	0.026	0.06	2.99
Weed control measures			
Weed free	0.632	1.67	58.00
Pendimethalin 750g ha^{-1}PE	0.596	1.65	46.32
Oxyfluorfan50g ha^{-1}PoE at 25 DAS	0.588	1.55	43.45
Weedy check	0.502	1.34	23.93
SEm+	0.009	0.02	1.03
CD (p=0.05)	0.026	0.06	2.99

Table 4. Effect of weed control measures and nutrient management on nutrient use efficiency of crop

Treatment	Nitrogen Use Efficiency	Phosphorus Use Efficiency	Potassium Use Efficiency
Nutrient management			
Control	0.00	0.00	0.00
75% RDF	2.85	6.41	12.82
100 % RDF	3.51	7.90	15.81
125 % RDF	3.18	7.16	14.32
SEm+	-	-	-
CD (p=0.05)	-	-	-

(PE) and oxyfluorfen @ 50 g ha^{-1} (POE at 25 DAS) also recorded more N, P and K uptake compared to weedy check. These treatments provided weed free environment to crop at early growth stage, wherein the major portion of the basal dose of fertilizer was applied to soil was

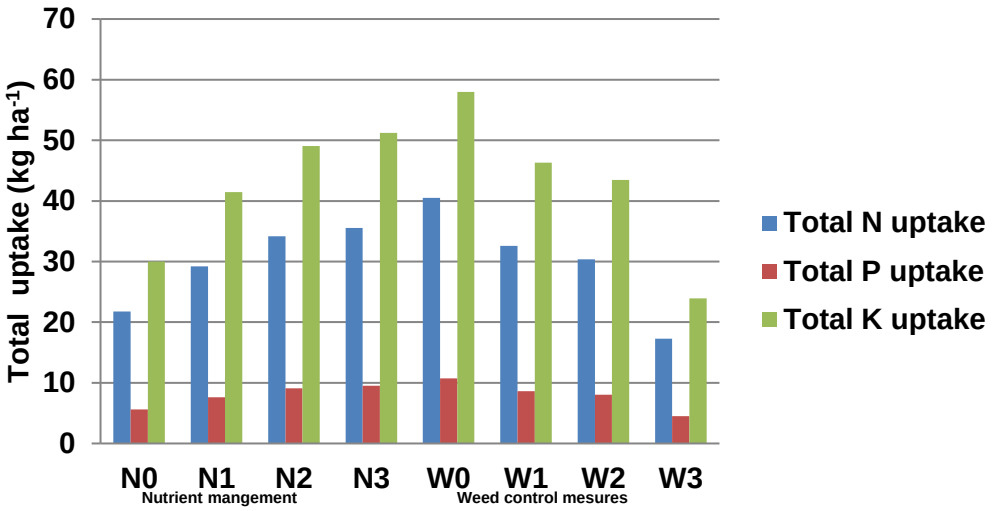

Fig. 1. Effect of nutrient management and weed control measures on total uptake

available to crop in contrast to weedy check. Similarly, at later stages, the applied nutrients under weedy check were utilized by weeds due to their greater competition and better root system. More availability of nutrients to crop under weed free condition under superior treatments increased their content in the plants, which resulted in higher crop dry matter and yields. Similar findings have also been reported by Mehriya *et al.* [4] and as well as Yadav and Sharma [5] in cumin, Yadav et al. [6]in coriander and Choudhary et al. [7] in fennel.

3.2 Effect of Nutrient Management

A significant increase in N, P and K content in seed and straw and their total uptake by crop recorded with the application of 100 % RDF over control but was found at par with 125 % RDF (Table 1-3). Significant improvement in uptake of nitrogen, phosphorus and potassium might be attributed to their respective higher content in seed and straw. Data presented in Table 4 indicated that increasing level of fertility affects the NUE. Significantly, highest N P K use efficiency was obtained with 100 % RDF 3.18, 7.90 and 15.81 kg kg^{-1}. Similar results have also been reported by Naher et al. [8] in fenugreek, Javiya *et al.* [9] in coriander, Mevada et al. [10] and Kalasare et al. [11] in fennel [12-13].

4. CONCLUSION

The study suggests that weed control measures and proper nutrient management are crucial for achieving high nutrient content and uptake in fennel crops. The weed free treatment and the application of pendimethalin at a rate of 0.75 kg ha^{-1} were found to be effective in controlling weeds and improving nutrient levels. Moreover, the use of 100% recommended dose of fertilizer was found to be the most effective nutrient management strategy, resulting in superior nutrient content, uptake, and nutrient use efficiency. These findings highlight the importance of integrated weed and nutrient management practices for optimizing crop productivity and quality.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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