Effect of Irrigation and Sowing Techniques on Weed dynamics in Alfalfa under South Saurashtra Agro-climatic Zone of Gujarat, India

Abstract

A field trial was conducted during winter cycle of November to April 2022-23 at Farming system research station, College of Agriculture, JAU, Junagadh to study the effect of irrigation and sowing method on alfalfa. The treatments given were: I_1: 0.6 IW/CPE, I_2: 0.8 IW/CPE, I_3: IW/CPE ratios and two sowing methods, M_1: Line sowing and M_2: Broadcast. The combination of treatments were tested in split plot design with three replications. The experimental field was heavily infested with mixed flora of sedge, grasses and broad-leaved weeds, *viz.* *cypers rotundus* L., *Echinocoloa coloa* L., *Chinopodium album* L., *Chinopodium murale* L., *Digera arvensis L.*, *Commelina benghalensis* L., *Cleome viscose* L., *Euphorbia spp.* L. Results showed that the irrigation scheduling and sowing method had significant effect on the weed density and dry weight of weed during the study. Significantly higher weed density and dry weight of weed was obtained with broadcasting as compared to line sowing at 25 cm apart.

Keywords: climate, weed, irrigation, sowing method and weed flora

Introduction

Climate change is now a widely accepted phenomenon. Concentration of CO_2 have risen from about 280 ppm to about 390 ppm and it is expected that by the end of 21st century, it will reach to the levels of 600-700 ppm, if current emission trends continue (IPCC, 2001). Climate models projected that the global earth surface temperature is likely to rise in a range of 1.1 to 6.4°C during the 21st century due to the rising CO_2 concentration (IPCC, 2004). Its rise could alter weed proliferation and competitive behavior in weedy vegetation as well as in crop stands (Tubiello *et al*., 2007). The anticipated changes in temperature and moisture projected under changing climates (IPCC, 2007) have obvious implications for germination and the spatial and temporal emergence of weed seeds and seedlings, which require more holistic investigation. There are concerns that global CO_2 enrichment will affect weeds and crop yields directly or indirectly through global warming and its associated changes in climate such as alteration in precipitation, wind pattern, rise in sea level and more flood and drought (Singh *et al.* 2016). Proper irrigation management can play a crucial role in weed control. Alfalfa requires adequate water supply for optimal growth, but excessive moisture can also favor weed germination and growth. Over-irrigation can create a favorable environment for weed seeds to germinate and compete with alfalfa plants. Conversely, under-irrigation can weaken alfalfa stands, making them more susceptible to weed competition. Appropriate nutrient management is essential for maintaining a healthy alfalfa stand that can outcompete weeds. Alfalfa is a nutrient-demanding crop, and providing sufficient nutrients can promote vigorous growth, canopy closure, and shading of the soil, which can suppress weed germination and growth. Sowing techniques: The sowing technique used for establishing alfalfa can also influence weed flora. Broadcasting involves spreading the alfalfa seeds uniformly over the soil surface. This technique may result in uneven seed distribution and greater exposure of soil to light, which can promote weed germination. Weed competition can be more pronounced in broadcast-seeded alfalfa stands. Drilling, on the other hand, involves placing the seeds in furrows or rows at a consistent depth. This method allows for better seed-soil contact and can result in more uniform emergence of alfalfa plants. Drilling can help establish a denser alfalfa stand, which can provide better competition against weeds.

The current atmospheric burden of the two most important greenhouse gases (carbon dioxide and methane), are unprecedented (Petit *et al*., 1999) and have emerged as the greatest ecological challenge of the 21st century (Kang and Banga, 2013). The impact of climate change on weedy vegetation may be manifested in the form of geographic range expansions (migration or introduction to new areas), alterations in species life cycles, shifting of weed flora and population dynamics. Through the lens of climate change, Peters *et al*. (2014) outlined three distinct types of shifts in weedy vegetation (range, niche and trait shifts), occurring at different scales (landscape, community, and population scales), respectively. Changes in weed biology, ecology and interference potential, in the wake of climate change, will result in complex crop-weed interactions that necessitate alternative adaptive mechanisms. There is a general perception that climate change will result in a differential growth pattern between crops and weeds, as major weeds of the world have the $_{C4}$ pathway and they will become more competitive, although this is certainly not a simple matter due to the adaptive mechanisms in weedy species.

Materials and methods

A field trial was conducted during the *Rabi* season 2022-23 at Farming system research station, College of Agriculture, JAU, Junagadh to study the effect of irrigation and sowing method on alfalfa. Sowing of seed has been done 17 November 2022. The treatments given were: I_1:0.6 IW/CPE, I_2:0.8 IW/CPE, I_3: IW/CPE ratios and two sowing methods, M_1: Line sowing and M_2: Broadcast. These six treatments were tested in split plot design with three replications. The experimental field was heavily infested with mixed flora of sedge, grasses and broad-leaved weeds, *viz. Echinocoloa coloa* L., *Chinopodium album* L., *Chinopodium murale* L., *Digera arvensis L.*, *Commelina benghalensis* L., *Cleome viscose* L., *Euphorbia spp.* L. Randomly five plants were selected from each plot and biometric observations of crop and weed parameters were recorded at periodic intervals. Weed density and dry weight were recorded with a quadrate of 0.25 m^2. The weeds fell in quadrate uprooted from the sampling area of 0.5 m^2. The uprooted weeds were first sundried and then kept in oven at 60-65^{0}C temperature for 48 hours for complete dry up and weighed. The dry biomass of weed was presented in g m^{-2}. The mean weekly maximum temperature during the crop growing period ranged from 25.7 to 39.3^{0}C with an average of 32.5^{0}C and the mean weekly minimum temperature varied from 9.4 to 23.5^{0}C with an average of 16.4^{0}C during 2022-23. Soil type was black medium clay soil with calcareous nature, pH of soil was 7.8, and it had medium available nitrogen and phosphorus. Mean annual rainfall of Junagadh was 1022 mm, it is average of last ten years.

Std. week	Temp. ^{0}C		RH %		WS (Km/hrs.)	BSS (Hrs.)	Evapo. (mm)
	Max.	Min.	Mor.	Eve.			
45	35.4	18.2	61	28	2.7	9.0	4.3
46	33.9	16.9	72	27	2.4	9.1	4.2
47	32.3	13.8	67	26	2.3	9.5	4.3
48	32.6	14.9	68	31	2.6	9.2	4.3
49	31.4	15.3	68	32	3.8	8.2	4.5
50	31.6	17.7	73	39	4.3	5.7	4.4
51	32.2	17.3	63	26	4.0	8.1	5.1
52	28.7	11.7	70	29	4.5	8.3	4.5
1	27.2	13.3	68	35	5.4	6.7	4.7
2	30.0	15.3	78	36	3.5	4.2	3.6
3	27.8	9.4	73	36	5.0	8.9	4.6
4	25.7	13.7	57	32	7.6	9.0	6.0
5	30.1	13.8	67	27	4.8	8.4	5.2
6	32.9	14.0	70	26	3.7	9.3	5.2
7	35.4	13.8	72	20	3.9	9.5	6.0
8	35.8	14.5	75	19	3.6	9.4	5.0
9	36.5	17.1	68	17	3.9	9.5	6.3
10	37.7	18.6	59	18	3.9	9.0	6.6
11	37.0	21.1	52	20	4.1	6.2	6.9
12	33.2	19.8	78	39	5.3	8.3	5.4
13	34.3	21.3	77	31	5.5	9.8	6.5
14	36.4	21.6	67	24	5.1	8.0	7.0
15	39.3	21.3	63	20	4.9	8.9	9.1
16	39.1	23.5	72	24	5.7	10.7	9.5

Table 1: Climatic data recorded during the field experiment 2022-23

Results and discussion

A total of twelve weed species were recognized in the field experiment. Out of twelve weed species, *Echinocloa coloa* species of wild rice was found in severe form. It has been recorded in severe form in each and every flushes. Climate change is the major issue in present scenario of the agriculture. Due to shifting of climate patterns and rise in the temperature, it is changing the ecology of weed, because *Echinocloa coloa* is a rainy cycle weed plant and now it is emerging in the winter cycle due to climate change (Table, 2).

Weed density (m^{-2})

Irrigation scheduling had significant effect on the weed density in the alfalfa fodder crop. Before harvesting of the crop, the density of weeds was recorded higher with irrigation scheduled at 0.6 IW/CPE ratio as compared to that at 1.0 IW/CPE ratio. Irrigation scheduled at 0.8 IW/CPE ratio recorded comparable weed density to 0.6 IW/CPE ratio. The difference between densities of weed among the treatments was there but it was statistically significant among 0.6 and 1.0 IW/CPE ratio. Optimum irrigation reduced the weed density as compared to deficit irrigation. Because plant expanded its canopy area under the optimum irrigation and it covered the soil surface. Facade *et al*. (2022) revealed that the effect of various irrigation intervals and treatments significantly influenced the weed density m^{-2}. Data concerning various irrigation intervals revealed the highest weed density at the 3 days irrigation interval while the lowest weed density was found in irrigation at the 9 day interval. Halli *et al.* (2021) also reported that the deficit irrigation recorded significantly higher weed density as compared to optimum irrigation. Sowing method had significant effect on the weed density. The significant higher weed density was recorded with broadcasting as compared to line sowing at 25 cm spacing during, before and after harvesting the crop (Table, 3). Under ambient conditions, water availability and temperature are the principal determinants of species distribution (Patterson *et al*., 1999), but there is recent addition to this list of CO_2 concentrations through the lens of climate change (Patterson, 1995 and Chauhan *et al*., 2014).

Sr. No.	Weed species	No. of weed flora m^{-2}				
		0.6 IW/CPE ratio	0.8 IW/CPE ratio	1.0 IW/CPE ratio	Drilling at 25 cm	Broadcasting
1	*Echinocloa colona*	24.0	32.2	34.0	26.0	34.1
2	*Asphodelus tunifolius*	3.5	3.5	3.5	2.3	4.7
3	*Parthenium hysterophorus*	1.5	2.3	2.8	2.4	2.0
4	*Cyperus rotundus*	4.3	9.5	9.3	7.6	7.9
5	*Chenopodium album*	1.2	4.0	2.2	2.8	2.1
6	*Chenopodium murale*	3.2	4.7	2.7	2.8	4.2
7	*Euphorbia spp.*	4.0	10.0	10.5	5.7	10.7
8	*Digera arvensis*	2.2	9.2	1.3	2.2	6.2
9	*Trianthema portulacastrum*	1.0	5.3	2.0	2.9	2.7
10	*Amaranths spp.*	1.3	1.3	0.5	1.4	0.7
11	*Wild mustard*	1.5	3.0	4.3	3.8	2.1
12	*Cammelina bengalensis*	1.5	1.7	2.0	1.4	2.0

Table 2: weed flora observed during winter cycle in alfalfa fodder crop

Table 3: Weed density (m^2) and weed dry weight ($g\ m^{-2}$) before and harvest of alfalfa during experiment 2022-23

Treatments	Weed density (m^{-2})		Weed dry weight ($g\ m^{-2}$)	
	Before harvest	After harvest	Before harvest	After harvest
I_1: 0.6 IW/CPE ratio	14.13 (186.58)	10.31 (97.58)	20.25 (391.83)	14.71 (204.93)
I_2: 0.8 IW/CPE ratio	13.69 (175.08)	9.68 (86.08)	19.62 (367.71)	13.81 (180.82)
I_3: 1.0 IW/CPE ratio	12.68 (149.08)	8.13 (60.08)	18.15 (313.12)	11.56 (126.22)
S.Em. ±	0.22	0.29	0.31	0.42
C.D. (P=0.05)	0.62	0.84	0.88	1.21
M_1: Drilling at 25 cm	12.77 (151.16)	8.29 (62.16)	18.28 (317.48)	11.78 (130.58)
M_2: Broadcasting	14.23 (189.33)	10.46 (100.33)	20.41 (397.63)	14.93 (210.73)
S.Em. ±	0.17	0.25	0.18	0.36
C.D. (P=0.05)	0.42	0.62	0.45	0.91
I × M Interaction	NS	NS	NS	NS

Chenopodium murale ***Echinocloa coloa*** ***Digera arvensis***

Pic 1. Morphology of plant

Weed dry weight ($g\ m^{-2}$)

Scheduling irrigation based on IW/CPE ratio had significant effect on the dry matter of the weed. Significantly higher weed dry weight was obtained with the irrigation scheduled 0.6 IW/CPE ratio as compared to IW/CPE ratio 1.0 but IW/CPE 0.8 ratio was recorded comparable dry weight of weed to IW/CPE ratio 0.6. Weed population and weed dry weight initially effected by irrigation because the germination of weed plant depends on the depth of the seed and disturbance of the soil, if soil is not disturbed than emergence of weed seed can be reduces. Facade *et al*. (2022) revealed that the highest dry weed biomass was produced at the 6 days irrigation interval which was statistically on par with the biomass produced at the 3 days irrigation interval, while the lowest dry weed biomass was recorded at the 9 days irrigation interval. Halli *et al.* (2021) also reported that the deficit irrigation recorded significantly higher weed dry biomass as compared to optimum irrigation. Sowing method had significant effect on dry weight of the weed. Broadcasting method of sowing has obtained significant maximum dry weight of weed as compared to the line sowing at 25 cm apart. Dry weight of weed of depends on the weed density and vegetative growth of the weed plant (Table 3).

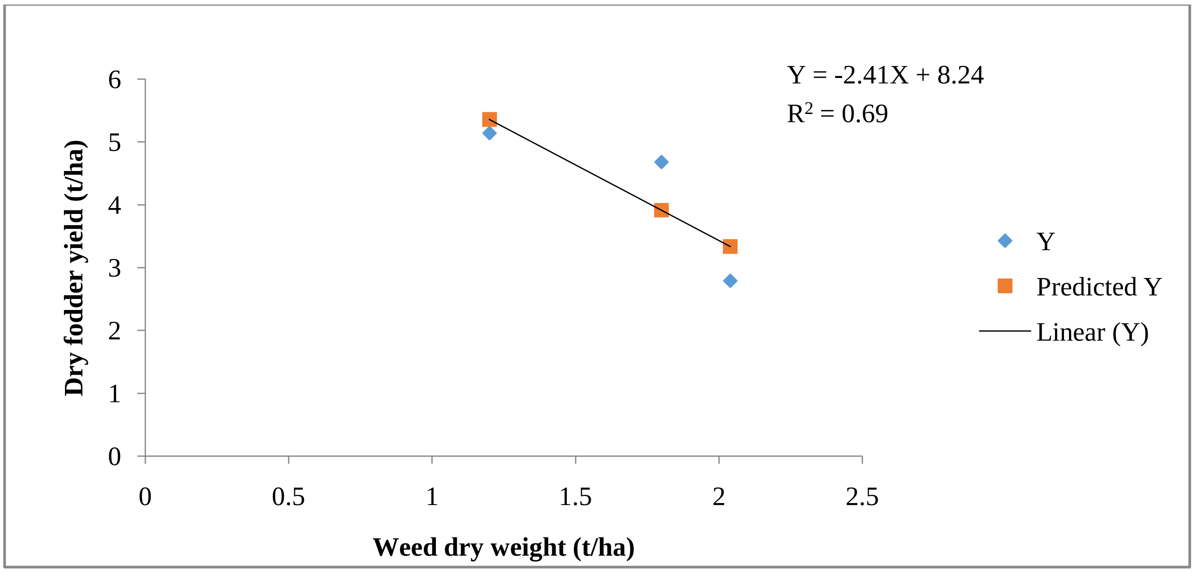

Fig. 1: Relationship between weed dry weight and dry fodder yield of alfalfa

Regression analysis of weed dry weight and reduction in crop yield

The relationship between data of weed dry weight and dry fodder yield of alfalfa was developed by regression analysis taking Y (Yield as dependent variable) and X (weed dry weight as independent variable) (Fig.1). The regression equation was Y= -2.41X+8.24 (R^2= 0.69). This indicates that with an increase in weed dry weight by 1 t/ha, dry fodder yield of alfalfa will decrease by 2.41 t/ha with coefficient of determination, R^2=0.69. From the study conducted it may be concluded that winter cycle alfalfa had mixed weed flora which reduced fodder yield up to 47.5%.

Conclusion

Optimum quantity of water does not affect the weed flora and dry matter of weed. It has been concluded that the sowing method has significant effect on the weed flora and dry matter of weed but climate change is the major force behind this phenomenon. Climate change is playing significant role in shifting the weed flora from one season to other. That is why, it is an alarming tune for the agronomists and weed scientists to manage the weeds in major crops under changing climate scenario.

Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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