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Seed Production of Forage Oat's (*Avena sativa* L.) as Influenced by Irrigation Scheduling (IW: CPE Ratios) and Nitrogen Levels

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Abstract

Seed yield was recorded higher under treatment I_3 and higher straw yield was recorded under the treatment I_1.Harvest index was found to be significant. While, significantly highest water use efficiency was registered under irrigation level I_3. The highest available nitrogen in soil was recorded under the treatment I_2 in the soil after harvest of the crop.The higher seed yield was recorded under the treatment N_2 and the straw yield increased significantly with each successive increase in nitrogen levels. Treatment gave significantly the highest straw yield. Significantly higher harvest index was recorded under the treatment N_2.Significantly the highest water use efficiency was recorded under the treatment N_2.The highest available nitrogen in soil was observed under the treatment N_3 .Treatment combination I_3N_2 recorded significantly higher seed yield (2648 kg ha^{-1}) and with respect to straw yield, wherein, treatment combination of I_1N_3 recorded significantly higher straw yield (10394 kg ha^{-1}).While, treatment combination I_3N_1 recorded significantly higher harvest index (22.27 %).

Keywords: Forage Oats, IW:CPE and Nitrogen Levels.

Introduction

Oats (Avena sativa L.) is an important cereal fodder crop having a wider adaptability in India, particularly in Northern, Western and Central states. It is a quick growing, highly nutritious forage crop having crude protein content of 12 to 14 per cent and as a concentrate feed, the grain, hay and silage of oats cover some scarcity periods of the year.

The goal of seed production system is to produce maximum yield of higher quality seeds at lower input. The nature of forage seed production is most complex and a number of environmental and physiological factors have a significant impact on seed production programme in forages.

Among the different approaches to schedule irrigation, climatological approaches based on irrigation water (IW) : cumulative pan evaporation (CPE) ratio was found to be the most appropriate as it integrates all the weather parameters giving them their natural waitage in a given soil-water plant continuum. Scheduling irrigation based on the date of the pan evaporation is likely to increase agricultural production at least by 15-20 per cent (Dastane, 1972).

Nitrogen plays a pivotal role in quantitative as well as qualitative improvement in the productivity of seed. It is an important constituent of proteins and chlorophyll. It improves the quality by increasing the protein content of fodder crops and governs to a considerable degree, the utilization of potassium, phosphorus and other elements (Patel *et al.,* 2007).

Aim of the Study

1. To find out the irrigation requirement for seed production of oats crop.
2. To find out the nitrogen requirement for seed production of oats crop.
3. To study the interaction effect of irrigation scheduling and nitrogen levels on seed production of oats crop.

Review of Literature

Effect of Irrigation Scheduling

Majumdar and Mandal (1984) studied the effect of irrigation based on pan evaporation and nitrogen levels on yield and water used in wheat at Visva-Bharti University, Sriniketan, West Bengal. The result revealed that the irrigation applied at IW: CPE ratio of 1.0 produced the maximum grain and straw yield of wheat. The maximum water use efficiency was achieved, when irrigation applied at IW: CPE ratio of 0.8.

Parihar and Tripathi (1990) carried out a field experiment at Kharagpur to study the yield and water use of wheat as influenced by irrigation scheduling. Experiment conducted with three irrigation levels 0.6, 0.8 and 1.0 (IW: CPE) ratios. Grain yields were 1793, 2608 and 2664 kg ha^{-1} in 1979 and 1734, 2471 and 2526 kg with 0.6, 0.8 and 1.0 IW: CPE ratios, respectively. They observed that water use efficiency was highest with 0.8 IW: CPE irrigation scheduling.

Gangaiah (2005) conducted an experiment at Regional Research Station, Indian Grassland and Fodder Research Institute, Dharwad (Karnataka) to study the response of oat varieties to irrigation schedules during winter season. Irrigation schedule based on IW: CPE ratio (0, 0.6, 0.9 and 1.2). They observed that irrigation scheduling at IW: CPE ratio 1.2 recorded the highest green fodder and dry fodder yields. While plant height, tillers/m row length and water-used efficiency was the highest at IW: CPE ratio 0.9.

Effect of Nitrogen Levels

Patel *et al.* (2003) studied the effect of cutting management and nitrogen levels on grain production of oats at Anand Agricultural University, Anand during *rabi* season of 1999-2000 and 2001-02. They observed that no cutting management and application of 80 kg N ha^{-1} significantly increased higher seed and straw yield.

Malik and Paynter (2010) at Department of Agriculture and Food Western Australia, Katanning WA, studied the influence of nitrogen and potassic fertilization on yield and quality of oats hay and grain yield, with two levels of nitrogen (15 and 80 kg ha^{-1}). They found that application of 80 kg N ha^{-1} gave highest grain yield.

Tiwana and Puri (2004) conducted a field experiment at Punjab Agricultural University, Ludhiana to find out the effect of *Azotobacter* and nitrogen levels on seed yield of oats. They incorporated different nitrogen levels (0, 40, 60, 80 kg ha^{-1}) on seed yield of oats. Result revealed that the application of 80 kg N ha^{-1} significantly increased the seed and straw yields of oats.

Interaction Effect of Irrigation Scheduling and Nitrogen Levels

Gill and Malik (1983) carried out an experiment at Haryana Agriculture University, Hisar, to study the response of irrigation scheduling and nitrogen levels on oats. The treatments consisted of three irrigation scheduling (120, 90 and 60 mm CPE) and nitrogen levels (0, 60 and 120 kg ha^{-1}). They observed significant interaction effect of irrigation scheduling at 60 CPE and nitrogen level 60 kg ha^{-1} yielded significantly the highest forage yield.

Joon *et al.* (1988) conducted an experiment at Haryana Agricultural University, Hisar to study effect of irrigation and nitrogen on fodder yield of oat. They observed that significant interaction effect combine application of irrigation scheduling at 70 mm CPE and nitrogen level of 160 kg N ha^{-1} gave higher green forage and dry fodder yield of oat.

Material and Methods

The present experiment was conducted in plot number C-1 at Main forage Research Station, Anand Agricultural University, Anand, (Gujarat) during *rabi* season of the year 2009 -2010.

The soil is representative of the region and is locally known as *Goradu* soil. The texture of the soil is loamy sand with 7.5 pH, organic carbon 0.43 %, EC 0.14 dsm^{-1}, Total N 0.033 kg ha^{-1}, $P_2 0_5$ 48.08 kg ha^{-1} and $K_2 0$ 139.91.00 kg ha^{-1}. Twelve treatment combinations comprised of Main plot treatments: Irrigation Levels I (4)-:(I_1)-Irrigation at Critical growth Stages, (I_2)-Irrigation at IW: CPE ratio of 0.6, (I_3)-Irrigation at IW: CPE ratio of 0.8, (I_4)-Irrigation at IW: CPE ratio of 1.0. while,Sub plot trtment: Levels of Nitrogen N (3): (N_1)-50 kg N/ha, (N_2)-75 kg N/ha, (N_3)-100 kg N/ha and its replicated four times with split plot deign. Total there were 48 experimental units.

Each experimental unit covered 6.0 m x 3.60 m as gross plot size. soil is very deep and fairly moisture retentive. The soil responds well to manuring and fertilizers.

Oat (Kent) was sown in the experiment. This variety was bred by the U. S. Department of Agriculture. It is resistant to rust, blight and lodging and popular in North India.

Result and Diccussion

Effect on Yield and WUE

Irrigation Levels (IW : CPE ratio)

Significantly the highest (2335 kg ha^{-1}) seed yield was recorded under the treatment N_2 (75 kg N ha^{-1}). The treatment N_2 and N_3 recorded 19.25 and 11.03 per cent higher seed yield than treatment N_1. The optimum nitrogen dose increased translocation towards yield attributing characters, accumulation in terms of higher panicle length, spikelets per panicle, grains per panicle and test weight which significant increase in seed yield. Maximum utilization of nutrient, water, solar radiation and increase metabolic activity might have produced maximum seed yield. (Majumdar and Mandal,1984).

Significantly highest straw yield (9953 kg ha^{-1}) were recorded under the treatment N_3 (100 kg N ha^{-1}). The treatment N_3 and N_2 recorded 27.01 and 14.75 per cent higher straw yield, respectively than treatment N_1. The increase in straw yield under the highest nitrogen level increased the availability and absorption of nitrogen, which result in more vegetative growth due to increase in plant height on the account of enlargement of cells and enhanced photosynthesis. Yield attributing characters resulting utilization of nutrient, water, solar radiation and increase metabolic activity might have produced maximum straw yield (Gangaiah, 2005)

The highest harvest index (20.80 %) was obtained under the treatment N_2 (75 kg N ha^{-1}) and the lowest harvest index (17.98 %) was obtained under the treatment N_3 (100 kg N ha^{-1}).

The treatment N_2 (75 kg N ha^{-1}) recorded significantly highest water use efficiency (7.29 kg ha^{-1}-mm). While the lowest water use efficiency (6.15 kg ha^{-1} -mm) was noticed under nitrogen level N_1 (50 kg N ha^{-1}). The results are agreement with those finding by (Parihar and Tripathi 1990).

Nitrogen levels

Significantly the highest (2335 kg ha^{-1}) seed yield was recorded under the treatment N_2 (75 kg N ha^{-1}). The treatment N_2 and N_3 recorded 19.25 and 11.03 per cent higher seed yield than treatment N_1.

The result in respect of straw yield significantly highest straw yield (9953 kg ha^{-1}) were recorded under the treatment N_3 (100 kg N ha^{-1}). The treatment N_1, N_2 and N_3 recorded straw yield 7836, 8992 and 9953 kg ha^{-1}. The treatment N_3 and N_2 recorded 27.01 and 14.75 per cent higher straw yield, respectively than treatment N_1. The increase in seed yield and straw yield under the highest nitrogen level increased the availability and absorption of nitrogen, which result in more reproductive and vegetative growth (Malik and Paynter (2010).

The highest harvest index (20.80 %) was obtained under the treatment N_2 (75 kg N ha^{-1}). These results were due to proportional increase or decrease in seed and straw yields under different levels of nitrogen. (Patel et al.,2003).

The treatment N_2 (75 kg N ha^{-1}) recorded significantly highest water use efficiency (7.29 kg ha^{-1} -mm). While the lowest water use efficiency (6.15 kg ha^{-1} -mm) was noticed under nitrogen level N_1 (50 kg N ha^{-1}). The results are agreement with those finding by Tiwana and Puri (2004).

Interaction Effect of Irrigation and Nitrogen Levels

Treatment combination of I_3N_2 (0.8 IW: CPE ratio and 75 kg N ha^{-1}) registered maximum seed yield (2648 kg ha^{-1}) of oats however it was at par with treatment combination of I_3N_3. Higher seed yield might be due to irrigation scheduling had the advantages of frequent irrigation application with proper interval as well as optimum dose of nitrogen provided maximum nutrient to individual plant its enhanced photosynthesis, utilization of nutrient, water, solar radiation and greater amount of photosynthesis increase metabolic activity have produced maximum seed yield. (Joon et al.,1988).

Treatment combination of I_1N_3 (Critical growth stages and 100 kg N ha^{-1}) recorded significantly higher straw yield (10394 kg ha^{-1}) and it was at par with treatment combinations of I_1N_2, I_3N_3, I_2N_3, I_4N_3, I_3N_2, and I_4N_2. The successive increasing in irrigation level and nitrogen level increased the availability and absorption of nitrogen which resulted in more vegetative growth due to increase in plant height, enlargement of cells and enhanced photosynthesis. Which might led significant increase in higher straw yield. (Joon et al.,1988).

Treatment combination of I_3N_1 (0.8 IW: CPE ratio and 50 kg N ha^{-1}) gave significantly higher harvest index (22.77 %) and it was at par with treatment combinations of I_2N_2, I_3N_2, I_2N_1, I_4N_2 and I_3N_3.

These results were due to proportional increase or decrease in seed and straw yields under different irrigation and nitrogen levels.

Effect on Soil Status

Irrigation Levels (IW : CPE Ratio)

Significantly the highest (111.92 kg ha^{-1}) available nitrogen in soil was recorded under treatment I_2 (0.6 IW: CPE ratio), while treatment I_3 (0.8 IW: CPE ratio) gave significantly the lowest available nitrogen in soil (93.31 kg ha^{-1}). Irrigation scheduling did not manifest any significant effect on available phosphorus and potassium in soil after harvest of the crop.

Table 1
Effect of Irrigation Scheduling and Nitrogen Levels on Yields, HI and WUE of Oats

Treatments	Seed yield (kg/ha^{-1})	Straw yield (kg/ha^{-1})	HI (%)	Water use efficiency (kg ha^{-1}mm)
Irrigation levels (IW : CPE ratio) (I)				
I_1 – Critical growth stage	2262	9818	18.90	6.46
I_2 - 0.6	1744	7571	19.33	6.98
I_3 - 0.8	2446	9052	21.39	8.15
I_4 - 1.0	2170	9267	19.05	5.43
S. Em. ±	87.76	398.07	0.59	0.30
C.D. (P=0.05)	280.76	1273.58	1.88	0.97
C.V. %	14.10	15.45	10.37	15.53
Nitrogen levels (kg ha^{-1}) (N)				
N_1- 50	1958	7836	20.22	6.15
N_2- 75	2335	8992	20.80	7.29
N_3- 100	2174	9953	17.98	6.82
S. Em. ±	28.54	255.63	0.47	0.09
C.D. (P=0.05)	83.31	746.12	1.39	0.27
I x N	Sign	Sign	Sign	NS
C.V. %	5.30	11.45	9.66	5.54

Table 2
Interaction Effect of Irrigation Scheduling and Nitrogen Levels on Seed Yield, Straw Yield and HI of Oats

Irrigation levels (IW : CPE) (I)	Nitrogen levels (kg ha^{-1}) (N)								
	Seed Yield (Kg/Ha)			Straw Yield (Kg/Ha)			HI (%)		
	N1	N2	N3	N1	N2	N3	N1	N2	N3
I_1 – Critical growth stage	2006	2453	2326	8731	10328	10394	18.90	19.30	18.49
I_2 - 0.6	1656	1827	1750	6395	6542	9776	20.83	21.96	15.18
I_3 - 0.8	2163	2648	2527	7541	9613	10003	22.27	21.62	20.27
I_4 - 1.0	2008	2412	2092	8678	9486	9638	18.87	20.31	17.97
S. Em. ±	57.08			511.22			0.95		
C.D. (P=0.05)	166.61			1492.22			2.77		

Nitrogen Levels

Significantly treatment N_3 (100 kg N ha^{-1}) recorded the highest available nitrogen in soil (121.84 kg ha^{-1}), while treatment N_1 (50 kg N ha^{-1}) gave significantly the lowest (77.30 kg ha^{-1}) available nitrogen in soil. Nitrogen levels did not manifest any significant effect on available phosphorus and potassium in soil after harvest of the crop.

Table 3
Effect of Irrigation Scheduling and Nitrogen Levels on Available Nitrogen, Phosphorus and Potassium after Harvest of Oats

Treatments	Nitrogen (kg/ha^{-1})	Phosphorus (kg/ha^{-1})	Potassium (kg/ha^{-1})
Irrigation levels (IW : CPE ratio) (I)			
I_1 – Critical growth stage	96.61	52.28	276.76
I_2 - 0.6	111.92	52.36	275.91
I_3 - 0.8	93.31	52.80	272.54
I_4 - 1.0	97.81	54.11	268.37
S. Em. ±	0.89	0.53	4.80
C.D. (P=0.05)	2.85	NS	NS
C.V. %	3.09	3.80	4.34
Nitrogen levels (kg ha^{-1}) (N)			
N_1- 50	77.30	52.83	266.68
N_2- 75	100.59	53.04	270.52
N_3- 100	121.84	52.78	282.98
S. Em. ±	1.54	0.55	4.77
C.D. (P=0.05)	4.52	NS	NS
I x N	NS	NS	NS
C.V. %	6.20	3.95	6.94

Conclusion

In light of the results obtained from this investigation, it is concluded that for securing maximum seed production with good quality and for getting higher net monetary realization, oats crop should be irrigated at 0.8 IW: CPE ratio along with 75 kg N ha^{-1} in sandy loan soils under middle Gujarat Agro-climatic conditions.

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