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Impact of nutrient efficiency in onion through weed management practices and nitrogen

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Abstract
Application of weed management treatments under varying levels of nitrogen is important in better onion (*Allium cepa* L.) production. Uptake of nitrogen (N) by onion plant is dependent upon many factors including type of weed species, intensity and the rate N fertilizer. To understand interactions among onion, applied N, and weed management is important in developing management strategies. A field experiment was conducted at SKN College of Agriculture, Jobner for two consecutive years during Rabi 2016-17 and 2017-18 to find out the efficient weed management in onion under varying levels of nitrogen. Among the different weed management treatments weed free check *i.e.* twice hand weeding treatment recorded significantly higher agronomic efficiency, apparent recovery of N and physiological efficiency of N to rest of the treatments except application of pendimethalin (PP) + oxadiargyl at 40 DAT or application of pendimethalin (PP) + 1 HW at 40 DAT, being statistically at par with each other. Similarly, highest agronomic efficiency, apparent recovery of N and physiological efficiency of N were obtained with 100 kg N ha^{-1} and declined with further increase in dose of N.

Keywords: NUE, weed management, pendimethalin, Oxyflourfen

Introduction
Onion (*Allium cepa* L.) belongs to family Alliaceae, is a biennial herbaceous and cross-pollinated vegetable. Onion is available in fresh, dehydrated and canned forms. They can be used chopped or sliced in almost every type of food. Onion can be grown successfully in any type of soil. A soil pH of 6.0 to 7.0 is recommended for the onion production (Baloch, 1994) [2]. The low productivity of onion depends on a number of factors. Fertility and weed management are often considered two of the most critical management factors impacting yield (Olson and Sander, 1988) [8]. Nitrogen (N) use efficiency can be influenced by soil properties, interactions among crops and weeds, and the rate of N applied. The uptake of N in a cropping system is based on the requirements of the crop as well as on the availability of N in soil. Nitrogen use efficiency represents the combination of N uptake efficiency, N use efficiency in plant tissue, and N concentration in produce at harvest (Weih *et al*., 2011) [11].

Materials and Methods
During *rabi* season of 2016-17 and 2017-18 an experiment was conducted at Horticulture farm, Department of Horticulture, SKN College of Agriculture, Jobner (Jaipur) Rajasthan having plot size of 1.50 M x 1.50 M in split plot design with three replications. The seeds of onion cultivar RO-252 were sown at a distance of 15x10 cm. for nursery raising in the 3rd week of September and the transplanting was done in the 2nd week of December for both years in flat beds. This experiment comprising seven weed management treatments in main plots *viz.*, unweeded (control), HW once at 20 DAT, HW twice at 20 and 40 DAT, Pendimethalin (PP) + Oxadiargyl at 40 DAT, Pendimethalin (PP) + 1 HW at 40 DAT, Oxyflourfen (PP) + Oxyflourfen at 20 DAT and Oxyflourfen (PP) + 1 HW at 40 DAT and four treatments of nitrogen levels in sub-plots *viz.*, 0, 50, 100 and 150 kg/ha. All packages of practices to raise good crop was done in the experiment.
Agronomic efficiency, apparent recovery and physiological efficiencies of nitrogen was calculated using following formula (Singh and Singh, 2012) [10]

$$\text{Agronomic efficiency of N } (AE_n) = \frac{Y_n - Y_c}{\text{N applied}}$$

$$\text{Apparent recovery (\%) of N } (RE_n) = \frac{U_n - U_c}{\text{N applied}} \times 100$$

$$\text{Physiological Efficiency of N } (PE_n) = \frac{Y_n - Y_c}{U_n - U_c}$$

Where:
Y = Yield of onion bulb (kg/ha)
U = Uptake of N by crop (kg/ha)
n and c = Yield/uptake of crop under N applied treatment and under control, respectively (kg/ha).

The observation on Agronomic efficiency, apparent recovery and physiological efficiencies of nitrogen for onion crop were statistically analysed by using methodology as suggested by Panse and Sukhatme (1985).

Results and Discussion

Two HW at 20 and 40 DAT (W_2) represented the significantly higher mean agronomic efficiency (22.95 kg bulb/kg N) than rest of the weed management treatments. Although, application of pendimethalin (PP) fb 1 HW at 40 DAT (W_4) and application of pendimethalin (PP) fb oxadiargyl at 40 DAT (W_3) were the next superior and equally effective treatments with respect to agronomic efficiency. Consistent with the foregoing suggestion, in the study, management of weeds resulted in good agronomic efficiency of applied N that ranged from 14.39 to 23.60 kg ha^{-1} (Table 1). Moreover, higher agronomic efficiency at 35.17 kg N ha^{-1} than 100 kg N ha^{-1} could be due to a effect of applied N resulting in higher bulb yield. On the other hand, agronomic efficiency values of 12.23 to 12.94 kg ha^{-1} were obtained under weedy checks showing the importance of appropriate weed management in onion production. Dobbermann (2005) [5] indicated that an agronomic efficiency value ranging from 10 to 30 is common, and values higher than 30 indicate efficiently managed systems. Similarly, Craswell and Godwin (1984) [3] reported that high agronomic efficiency could be obtained if the yield increment per unit applied nutrient was high. This result is in agreement with the finding of Amir *et al.* (2012) [1] who reported that increase in N fertilizer rates resulted in a decline in agronomic efficiency.

The decrease in apparent nitrogen recovery efficiency under the weedy check could be due to more competitiveness of the weeds, using most of the N resource that otherwise could be taken up the crop. The higher apparent N efficiency recorded under weed free treatment *i.e.* Two HW at 20 and 40 DAT (W_2) might be due to high utilization of nitrogen by the crop in absence of competition from the weeds. Although, application of pendimethalin (PP) fb 1 HW at 40 DAT (W_4) and application of pendimethalin (PP) fb oxadiargyl at 40 DAT (W_3) were the next superior and equally effective treatments with respect to apparent N efficiency. The weedy check plots had the lowest N apparent recovery efficiency of nitrogen that ranged from 3.38% to 4.07% while the apparent recovery efficiency of nitrogen efficiency obtained in this study under weed management practices ranged from 3.96% to 7.42%. The increased trend of NAR efficiency due to increased rate of N could also be due to higher total N uptake from 100 kg N ha^{-1} after that it is declined with increasing level of N. Furthermore, NAR efficiency of a nutrient is mainly a function of indigenous nutrients supply and the amount of fertilizer that can be expected in situations where sink potential is large e.g. favorable climatic condition, sufficient water supply and mainly low weed pressure (Fageria and Baligar, 2005) [6]. Similarly, Delogu *et al*. (1998) [4] reported increased in apparent nitrogen recovery efficiency at the rate of 150 kg N ha^{-1}.

The higher physiological efficiency of N (NPE) in the weed free condition *i.e.* Two HW at 20 and 40 DAT (W_2) might be attributed to adequately available nutrient during bulb development stage that might have increased the assimilation and redistribution of N from the vegetative plant components to onion bulb. This might be due to improved soil environment under hand weeding especially soil aeration which might have also contributed to higher total N and water uptake compared to herbicide treatments. The highest physiological efficiency of N (341.12 kg bulb/kg N uptake) were obtained when level of nitrogen fertilization was raised from 0 to 100 kg/ha. Thereafter, increase in N level resulted progressive decline in NPE. The lowest values NPE was recorded when nitrogen was applied at 50 kg/ha. In conformity with this result, Roberts (2008) [9] reported higher N physiological efficiency under the application of lower levels of nitrogen than higher one.

Table 1: Effect of weed management and nitrogen levels on Agronomic efficiency and apparent recovery of N for onion crop

Treatments	Agronomic efficiency of N (kg bulb/kg N)			Apparent recovery of N (%)		
	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
Main plots (Weed management)						
W_0 - Weedy check (control)	12.94	12.23	12.59	4.07	3.38	3.73
W_1 - One HW at 20 DAT	15.24	14.39	14.82	4.79	3.96	4.38
W_2 - Two HW at 20 & 40 DAT	23.6	22.29	22.95	7.42	6.18	6.80
W_3 - Pendi.(PP) + Oxad. at 40 DAT	22.52	21.27	21.90	7.08	5.88	6.48
W_4 – Pendi.(PP) + 1 HW at 40 DAT	23.06	21.78	22.42	7.25	6.05	6.65
W_5 - Oxy. (PP) + Oxy. at 20 DAT	17.12	16.18	16.65	5.38	4.47	4.93
W_6 - Oxy.(PP) + 1 HW at 40 DAT	20.36	19.23	19.80	6.39	5.34	5.87
S.Em+	0.80	0.52	0.48	0.25	0.14	0.15
CD (P=0.05)	2.47	1.61	1.41	0.78	0.45	0.43
Sub plots (Nitrogen levels kg/ha)						
N_0 - 0	-	-	-	-	-	-
N_1 - 50	12.98	12.26	12.62	4.08	3.40	3.74
N_2 - 100	35.17	33.22	34.20	11.05	9.20	10.13
N_3 - 150	28.90	27.30	28.10	9.08	7.56	8.32
S.Em+	0.40	0.30	0.25	0.13	0.08	0.08
CD (P=0.05)	1.15	0.84	0.70	0.36	0.23	0.21

NS = Non-significant, Sig. = Significant, fb = followed by, pendi = pendimethalin, oxa. = oxadiargyl, oxy. = oxyfluorfen, PP = pre plant, POP = post plant

Table 2: Effect of weed management and nitrogen levels on physiological efficiency of N for onion crop

Treatments	Physiological efficiency of N (kg bulb/kg N uptake)		
	2016-17	**2017-18**	**Pooled**
Main plots (Weed management)			
W_0 - Weedy check (control)	111.83	139.26	125.55
W_1 - One HW at 20 DAT	131.64	163.92	147.78
W_2 - Two HW at 20 & 40 DAT	203.86	253.86	228.86
W_3 - Pendi.(PP) + Oxad. at 40 DAT	194.54	242.26	218.40
W_4 – Pendi.(PP) + 1 HW at 40 DAT	199.20	248.06	223.63
W_5 - Oxy. (PP) + Oxy. at 20 DAT	147.95	184.23	166.09
W_6 - Oxy.(PP) + 1 HW at 40 DAT	175.91	219.05	197.48
S.Em+	6.94	5.94	4.68
CD (P=0.05)	21.37	18.31	13.67
Sub plots (Nitrogen levels kg/ha)			
N_0 - 0	-	-	-
N_1 - 50	112.17	139.68	125.92
N_2 - 100	303.86	378.38	341.12
N_3 - 150	249.65	310.88	280.27
S.Em+	3.49	3.37	2.43
CD (P=0.05)	9.97	9.61	6.82
Interaction (W X N)	NS	NS	NS

NS = Non-significant, Sig. = Significant, fb = followed by, pendi = pendimethalin, oxa. = oxadiargyl, Oxy. = oxyfluorfen, PP = pre plant, POP = post plant

Conclusion

Results from these experiments indicate that relationships between weed management under varying levels of nitrogen in onion exist with respect to N content in onion tissue early in the season with some of the applied N for onion being absorbed by weeds. Results showed that even though some differences in N use efficiencies in onion were noted due to weed interference, these differences did not translate into differences in onion bulb yield. A reduction in N use efficiencies due to increased weed interference irrespective of N rate is a reminder that timely weed control is critical regardless of fertility practices in onion crop.

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