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Yield Response Factor for Onion (*Allium Cepa*. L) Under Deficit Irrigation in Semiarid Tropics of Maharashtra.

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ABSCRACT: *This paper presents a study of yield response factor (*Ky*) for onion crop cultivated under deficit irrigation in Rahuri region (Maharashra). The field experiment was conducted to determine the yield response factor of the onion (Allium cepa L.) cv. N-2-4-1 crop under the deficit irrigation approach during summer season of 2012 at Instructional Farm of the Department of Irrigation and Drainage Engineering,,Mahatma Phule Krishi Vidyapeeth Rahuri. Experiment was carried out in Randomized Block Design (RBD) with 27 treatments and two replications based on different combinations of the quantity of water stress during different crop growth stages. Average daily crop water use (crop consumptive use) were estimated from the soil moisture content using the soil moisture depletion method.The yield response factor (*Ky*) were obtained by relating relative yield decreases to relative crop water use deficits.The relative yield decreases of the onion crop were proportionally greater with increase in evapotranspiration deficit.It shows the response of yield with respect to the decrease in water consumption. Seasonalcrop response factor for onion crop was determined as 1.58 for irrigationtreatments. The yield response factors developed in this study are reliable and could be used in irrigation design and scheduling for onion in the study area.*

Keywords: *Onion, deficit irrigation, crop coefficient (K_c), yield response factor (*Ky*), crop water use.*

INTRODUCTION

Onion *(Allium cepa L.)* is one of the important vegetable crops commercially grown in India.India is the second largest producer of onion in the world,next only to China. In India, onion is being grown in an area of 0.83 million hectares with production of 13.57 million tones and the productivity is 16.30 t ha^{-1} which is low. Maharashtra is the leading onion producing state followed by Karnataka, Gujarat etc.

In Maharashtra, onion is cultivated in an area of 1.65 lakh hectares with production of 30.32 lakh tonnes and the average productivity is 18.40 tonnes per hectare (Bijay Kumar, 2010) which is low compared to world average. A research gap in the region where onion is produced in Rahuri region of Maharshtra is the knowledge of water requirement of the onion crop under deficit irrigation. Moreover, the consequences of deficit irrigation regimes are yet to be fully understood. A key parameter commonly required in determining crop water requirement and prediction of yield - water response to deficit irrigation is yield response factor (Ky). The yield response factor (Ky) is ratio of relative yield reduction to relative evapo-transpiration deficit.

The seasonal yield response factor values for onion crop reported by FAO and other scientists are different at different locality. FAO reported seasonal Ky value for onion crop is 1.13 (FAO Irrigation and Drainage Paper No. 33.). The yield response factor (Ky) of the onion crop 1.15, (Henry E. Igbadun1 *et al.*, 2012).Doorenbos and Kassam (1986) reported yield response factor (Ky) value of 1.5 for onion and Serhat Ayas and Çiðdem Demirta (2009) reported yield response factor (Ky) value of 1.132 for onion under deficit irrigation during the whole growing season.

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Yet the yield response factor of onion crop for Rahuri region (Maharashtra) is not reported by any research work. Hence the present study was carried out with the objective to determine the yield response factors of the onion crop under the deficit irrigation approach.It is anticipated that the information generated in this study will be useful for developing crop water requirements for irrigated onion under deficit irrigation regimes and for the overall improvement of irrigation water management in the study area.

MATERIALS AND METHODS

The field experiment to determine the yield response factor of the onion *(Allium cepa L.)* cv. N-2-4-1 crop under the deficit irrigation approachwas conducted during summer season of 2012 at Instructional Farm of the Department of Irrigation and Drainage Engineering, Dr. Annasaheb Shinde College of Agricultural Engineering, Mahatma Phule Krishi Vidyapeeth Rahuri. There was no rainfall during period ofexperimentation. Experiment was carried out in Randomized Block Design (RBD) with 27 treatments and two replications based on different combinations of the quantity of water stress during different crop growth stages *i.e.* Vegetative Stage (VS)-Up to 50 days, Bulb Development Stage (BDS)-50 to 75 days and Bulb Enlargement Stage (BES)-75 to 100 days and water stress *i.e.* no Stress-(0.00S), 20% Stress-(0.20S) and 40% Stress-(0.40S).

Treatments are

T1. VS-0.00S, BDS-0.00S, BES-0.00S,
T2. VS-0.00S, BDS-0.00S, BES-0.20S
T3. VS-0.00S, BDS-0.00S, BES-0.40S,
T4. VS-0.00S, BDS-0.20S, BES-0.00S
T5. VS-0.00S, BDS-0.20S, BES-0.20S,
T6 VS-0.00S, BDS-0.20S, BES-0.40S
T7. VS-0.00S, BDS-0.40S, BES-0.00S,
T8. VS-0.00S, BDS-0.40S, BES-0.20S
T9. VS-0.00S, BDS-0.40S, BES-0.40S,
T10. VS-0.20S, BDS-0.00S, BES-0.00S
T11. VS-0.20S, BDS-0.00S, BES-0.20S
T12. VS-0.20S, BDS-0.00S, BES-0.40S
T13. VS-0.20S, BDS-0.20S, BES-0.00S
T14. VS-0.20S, BDS-0.20S, BES-0.20S
T15. VS-0.20S, BDS-0.20S, BES-0.40S
T16. VS-0.20S, BDS-0.40S, BES-0.00S
T17. VS-0.20S, BDS-0.40S, BES-0.20S
T18. VS-0.20S, BDS-0.40S, BES-0.40S,
T19. VS-0.40S, BDS-0.00S, BES-0.00S,
T20. VS-0.40S,BDS-0.00S,BES-0.20S,
T21. VS-0.40S, BDS-0.00S, BES-0.40S
T22. VS-0.40S, BDS-0.20S, BES-0.00S
T23. VS-0.40S, BDS-0.20S, BES-0.20S
T24. VS-0.40S, BDS-0.20S, BES-0.40S
T25. VS-0.40S, BDS-0.40S, BES-0.00S
T26. VS-0.40S, BDS-0.40S, BES-0.20S
T27. VS-0.40S, BDS-0.40S, BES-0.40S

Irrigations were scheduled at every growth stage of onion crop. The depths of irrigation water were applied according to the treatments.

In this study the yield response factor was computed using the Doorenbos and Kassam (1979) equation re-arranged as,

$$1-\frac{Ya}{Ym}=Ky\left(1-\frac{Eta}{Etm}\right)$$

Where

Ya is the actual yield (t ha^{-1}), Ymis the maximum yield (t ha^{-1}), ETais the actual evapotranspiration (mm) and ETmis the maximum evapotranspiration (mm). Values of Ky indicate the response factor of onion to deficit irrigation.

RESULTS AND DISCUSSION

Onion Yield as Influenced by Water Stress

The average onion yield for two replications for all the treatments are given in table 2. These were analyzed statistically for randomized block design. The yields were statistically significant. The mean yields along with CD at 5 % are presented in table1.

It is observed from above table that the higher yields are observed in trématent T1 (0% stress at vegetative stage, bulb development stage and bulb enlargement stage) followed by T4, T3, T10, T11, T5, T20, T21, T12, T19, T6, T16, T7, T13, T8, T22, T15, T18, T9, T17, T18, T23, T14, T24, T25, T26 and T27. The onion yield are observed lowest at T27 (40% stress at vegetative stage, bulb development stage and bulb enlargement stage) However, the yields of treatments T1 and T4. T2, T3 and T10 are at par. The yields of treatments T5, T11, and T20 are at par. The yields of treatments T6, T7 and T16 are at par. The yields of treatments T8, T13, T15 and T22 are at par.

Table 1
Effect of deficit irrigation water applied on yield (t/ha) at various growth stages of onion crop

Treatment	*Depth of total irrigation water applied, mm*	*Marketable yield, kg/ha*
T1	529	42518
T2	504	38554
T3	469	37217
T4	512	42363
T5	485	35854
T6	481	30698
T7	468	30408
T8	478	28910
T9	445	26900
T10	484	38490
T11	45	36328
T12	446	32049
T13	445	29049
T14	460	25926
T15	440	28326
T16	431	30574
T17	405	26833
T18	404	27115
T19	456	31742
T20	455	34645
T21	400	32710
T22	427	28807
T23	398	26664
T24	378	24470
T25	405	22898
T26	373	22273
T27	358	21349
	S.E.±	1478
	C.D. at 5%	4297

The yields of treatments T15, T8, T14, and T22 are at par. The yields of treatments T9, T17, T23, and T24 are at par. Statistically it is clear that the vegetative stage of the onion crop with no water stress gives higher onion yield at C.D.5% (6.77). Thus, the onion yields are higher with less water stress and reduced with increase in water stress.

YIELD RESPONSE FACTOR (Ky)

Table 2 shows the relative decreases in seasonal crop water use and bulb yield in 2012 season.

Yield response factor (Ky) indicates a linear relationship between the decrease in relative water consumption and the decrease in relative yield. It shows the response of yield with respect to the decrease in waterconsumption. In other words, it explains the decrease in yieldcaused by the per unit decrease in water consumption. Seasonalcrop response factor was determined as 1.58 for irrigation treatments (Figure 1). Values of Ky increased with increasing water deficit.

Table 2
Relationship between the decrease in relative water use and decrease in relative yield for onion

Treatment	*Eta*	*Etm*	*Ya*	*Ym*	*1-Eta/Etm*	*1-Ya/Ym*
T1	529	529	42.518	42.518	0	0
T2	504	529	38.554	42.518	0.047	0.093
T3	469	529	37.218	42.518	0.113	0.124
T4	512	529	42.364	42.518	0.032	0.003
T5	485	529	35.855	42.518	0.083	0.156
T6	481	529	35.48	42.518	0.090	0.165
T7	468	529	32.942	42.518	0.115	0.225
T8	478	529	35.087	42.518	0.096	0.174
T9	445	529	26.901	42.518	0.158	0.367
T10	484	529	38.49	42.518	0.085	0.094
T11	454	529	36.328	42.518	0.141	0.145
T12	446	529	32.049	42.518	0.156	0.246
T13	445	529	29.049	42.518	0.158	0.316
T14	460	529	33.181	42.518	0.130	0.219
T15	440	529	28.327	42.518	0.168	0.333
T16	431	529	30.574	42.518	0.185	0.280
T17	405	529	26.833	42.518	0.234	0.368
T18	404	529	27.115	42.518	0.236	0.362
T19	456	529	31.742	42.518	0.137	0.253
T20	455	529	34.645	42.518	0.139	0.185
T21	400	529	32.71	42.518	0.243	0.230
T22	427	529	28.807	42.518	0.192	0.322
T23	398	529	26.664	42.518	0.247	0.372
T24	378	529	24.471	42.518	0.285	0.424
T25	405	529	22.899	42.518	0.234	0.461
T26	373	529	22.273	42.518	0.294	0.476
T27	358	529	21.349	42.518	0.324	0.497

The relationship between relative yield reduction and relative evapotranspiration deficit for onion yield is estimated. Figures 1 show the yield response factor (Ky) for the onion crop under deficit irrigation treatment, obtained by plotting the data of the relative yields and relative seasonal crop water use of the experimental season of each treatment. The yield response factor (Ky) for onion was found to be 1.58 (R^2 = 0.843) for whole growing season. Result obtained was in agreement with those reported by Doorenbos and Kassam (1986). They reported yield response factor (Ky) value of 1.50 for onion under

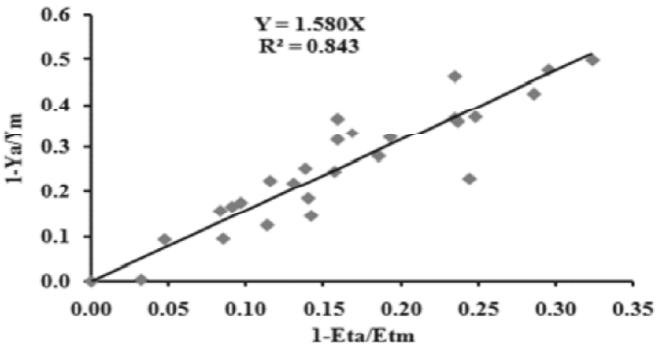

Figure 1: Yield response factor (Ky) of onion crop under deficit irrigation treatment

deficit irrigation during the whole growing season. This result indicated a high impact of soil-water stress treatment on the onion yield. Therefore, water management of onion is extremely important at all stages of plant development due to its influence on onion yield and consequently on the quality.

CONCLUSION

1. The results indicated a high impact of soil-water stress treatments on the onions yield.
2. The crop water use of the onion crop decreased with increase in irrigation deficit.
3. The yield response factor (Ky) for onion in semiarid tropics of Maharashtra was found to be 1.58for whole growing season.

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