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National Academy of Agricultural Science (NAAS) Rating : 3. 03

Effect of Split Application of Nutrients Through Fertigation on Growth, Yield and Quality of Onion

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Abstract: *A field experiment was conducted during the rabi season of 2012-2013 at Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to study the efficacy of split application of N and K on crop growth, yield and quality of onion.The experiment was laid out in Randomized Block Design with four replications and five treatments having four different levels (50 per cent, 75 per cent, 100 per cent and 125 per cent RDNK ha^{-1}) through fertigation in five splits (10, 20, 25, 25, 20 percent fertilizers at 10, 20, 40, 60 and 80 days after transplanting respectively) and P as basal compared with 100 per cent soil application of fertilizers. The experimental site was established with inline drip irrigation system (16 mm) lateral laid out at 120 cm with 60 cm dripper spacing. The uniform soil moisture distribution closer to the field capacity was noticed throughout the growth period. Application of 125 per cent recommended dose of N and K ha^{-1} through fertigation significantly increased all the growth and yield attributing components viz. plant height, leaf area, dry matter per plant,bulb polar diameter, equatorial diameter, weight of fresh bulb and bulb dry weight which was found comparable with 100 per cent level of N and K ha^{-1} through fertigation.Drip fertigation at 125 per cent recommended dose of N and K recorded significantly higher onion bulb yield (37.78 t ha^{-1}) which was followed by 100 per cent fertigation of RDNK (37.57 t ha^{-1}). Fertigation at 75 per cent N and K ha^{-1} recorded higher, but comparable yield with 100 per cent RDNK ha^{-1} applied through soil indicating 25 per cent fertilizer saving compared to conventional soil application.The quality parameters of onion viz.TSS, protein percentage and total phenols were improved by drip fertigation with different levels of N and K fertilizers.*

Keywords: *Drip Fertigation,Growth,Onion, RDNK,Yield.*

INTRODUCTION

Onion is the major cash crop giving high return within short period. It is the only crop which will fit after cotton under high input management.India is the second largest producer of onion in the world, though; India significantly lags behind in the productivity or yield of the onion. Drip fertigation provides an efficient method of fertilizer delivery and the availability of soil moisture and nutrients at root zone of the crops which influences the uptake of nutrients, growth and yield of the crop. Tripathi *et al*. [16] reported that the slow and frequent application of predetermined rate of water application could provide constant soil moisture availability to the crop at root zone resulting in increased yield of onion. Among the various factors responsible for high crop yield, the use of appropriate quantity of fertilizer at proper time plays a vital role in enhancing the productivity of onion. Onion requires higher level of N, P and K fertilizer for maximum yields than most other vegetable crops. The shallow roots and dense population of onion make them responsive to fertilizers. Application of fertilizers at appropriate stages of crop growth ensures a regular flow of both water and nutrients resulting in increased growth rates and higher yields. Fertigation can be done at pre-determined schedule according to the developmental and physiological stage of onion crop which improves availability of nutrients and their uptake by roots and nutrient use efficiency.

Split application of nitrogen and potash ensures required nutrients in right time and in right quantity for getting higher onion bulb yield with minimum

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loss of nutrients. The right combination of water and nutrients is a prerequisite for higher yields and good quality crop production. In this regard, fertigation may play an important role in agriculture without affecting the soil health adversely. Keeping the above mentioned facts in view,an attempt has been made to study the response ofonion to split application of fertilizers through fertigation in Vidarbha region of Maharashtra state.

METHODOLOGY

A field experiment was conducted in *rabi* season during the year 2012-2013 at Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to study the efficacy of split application of N and K on crop growth, yield and quality of onion (Var. Agri Found Light Red). Soil of the experimental plot was clayey in texture, low in organic carbon, slightly alkaline in reaction, low in available nitrogen and phosphorus and fairly high in available potassium. The experiment was laid out in Randomized Block Design with four replications and five treatments having four different levels of drip fertigation in five splits at 50 per cent, 75 per cent, 100 per cent and 125 per cent of recommended dose of N and K given through fertigation and P as basal compared with 100 per cent soil application of fertilizers. The experimental site was established with inline drip irrigation system (16 mm) lateral laid out at 120 cm with 60 cm dripper spacing. Drip irrigation was scheduled based on 2 days cumulative pan evaporation (CPE) and fertigation was as per schedule prepared for onion.

The recommended fertilizer dose was 150:50:80 NPKkg ha-1.The fertigation was given through fertigation tank of 90 lit. capacity.N and K fertilizer were supplied through straight fertilizer *i.e.* Urea and murate of Potash (White-water soluble) through drip. Phosphorus was applied in the form of single super phosphate as a basal. The quantity of fertilizer was given in five splits (10 % at 10 days after transplanting, 20% at 20 DAT, 25% at 40 DAT, 25% at 60 DAT and 20% at 80 DAT.). The fertilizer was applied as per the treatments. Half of the nitrogen and full dose of phosphorus and potash were applied as basal application at the time of sowing in the conventional methods. Remaining half dose of nitrogen was top-dressed at 30 days and at 60 days after transplanting as per the treatments.

The volume of irrigation water to be applied per plotwas determined by the formula as per the FAO Irrigation Water Management Training Manual No. 3 (1986). The total quantity of water used for onion was 479.19 mm. Effective rainfall was taken into account while scheduling irrigation through drip. Soil moisture content was estimated by gravimetric method. Soil samples were taken at a distance of 0, 15, 30 from dripper point (horizontal) and 0-15, 15-30 and 30-45 cm depth (vertical) for studying soil moisture irrigation regime during two consecutive irrigation cycles. This observation was done in rain free period. The values were expressed in per cent soil moisture by weight.

RESULTS AND DISCUSSION

Soil moisture distribution

The soil moisture content was found closer to the field capacity in the root zone at the emitter point and soil moisture content showed progressive decrease both vertically and horizontally from the emitter location, but slightly lower moisture percentage was recorded 48 hrs. after drip irrigation compared to soil moisture recorded after 24 hrs. (Table 1). The uniform moisture distribution due to increased frequency of irrigation at alternate days to onion led to higher and constant moisture availability nearer to field capacity. This trend of soil moisture distribution indicated optimum soil water availability conditions for the crop. The crop was irrigated with drip and experienced full irrigation without any stress period due to which shallow rooted onion crop extracted adequate moisture and nutrients efficiently without any losses, which increased the crop growth as well as yield of crop.

Table 1
Soil moisture distribution (%) 24 and 48 hrs after drip irrigation at 100 percent pan evaporation in onion

Vertical Depth from soil surface (cm)	*Horizontal distance from emitter (cm)*	*Soil moisture distribution (%)*	
		24 hrs	*48 hrs*
0-15	0	32.4	30.4
	15	30.6	28.5
	30	28.2	25.7
15-30	0	31.5	28.3
	15	29.6	27.5
	30	28.1	25.0
30-45	0	29.5	26.4
	15	27.9	25.6
	30	26.0	24.8

The positive response of such soil moisture distribution pattern due to drip irrigation in increasing yield in onion was also reported by Mallikarjun Reddy *et al*. [8] and Bagali *et al.* [1]

EFFECT ON GROWTH

The growth attributes of onion *viz*. plant height, leaf area, dry matter accumulation were found higher at 125 per cent RDNK ha^{-1} which was found comparable with 100 per cent level of N and K fertigation as indicated in Table 2. Drip fertigation at 75 per cent of RDNK and 100 per cent soil application treatments were comparable for all the growth characters. Concomitant increase in all the growth attributes were noticed with each increasing level of drip fertigation of recommended dose of N and K from 50 to 125 per cent. Maximum plant height, leaf area and dry matter accumulation with higher level of fertigation might be due to frequent application of fertilizers at convenient interval during the crop growth period which increased the available nutrient status in the root zone thus increased the uptake and growth. Khalaf [7] and Prabhakar *et al* [12] also reported the positive effect of N and K fertigation on plant height and other growth parameters compared to soil application method.

Drip fertigation at 125 per cent RDNK ha^{-1} produced maximum dry matter at harvest stage but was found statistically non significant with 100 per cent fertigation of N and K. 100 per cent soil application of RDNK ha^{-1} and 75 per cent fertigation of RDNK ha^{-1} were equally effective in producing dry matter per plant and found significantly at par with each other. At harvest stage higher level of 125 per cent fertigation recorded 22.10 per cent increase over soil application method indicating that higherlevel of fertigation were found better than conventional method of fertilizer application in increasing the dry weight. Dry matter accumulation got increased as the level of fertilizers (NK) application increased from 50 per cent to 125 per cent RDNK ha^{-1}.

In the present study, dry matter production increased with increased levels of N and K. This would have helped for better protein synthesis resulting in production of taller plants with larger leaves thereby higher leaf weight, plant height and number of leaves as well as fresh and dry weight of plants was increased with fertigation of N and K nutrients. These results were similar with findings of Ewais *et al* [3]. They reported higher dry weight with higher level of fertigation. Hebbar *et al*. [5] and Shedeed *et al*. [15] also observed significant increase in dry weight at higher dose of fertilizers given through fertigation in tomato.

Effect on Yield Attributing Characters

The yield attributing components *viz*. weight of fresh bulb, bulb dry weight bulb polar diameter, equatorial diameter, also responded well to different fertigation levels. (Table 2).

Each increment in the levels of N and K applied through drip in five splits increased the bulb fresh weight and bulb dry weight at harvest. Highest bulb fresh weight at harvest (133.21 g) and bulb dry weight (19.81 g) was recorded when 125 per cent level of RDNK ha^{-1} was given through fertigation being comparable with 100 per cent RDNK ha^{-1}. The

Table 2
Growth, yield attributing characters and onion bulb yield at harvest as influenced by different treatments

Treatments	*Plant Height (cm)*	*Leaf Area (dm^2)*	*Dry Matter Plant^{-1} (g)*	*Bulb Fresh Weight (g)*	*Bulb Dry Weight (g)*	*Bulb Polar Diameter (mm)*	*Bulb Equatorial Diameter (mm)*	*Onion Bulb Yield (tha^{-1})*
T_1: DI +100% RDNK soil application	66.95	3.14	21.01	115.75	14.65	52.84	59.35	29.56
T_2: DF+ 50% RDNK	60.68	2.79	18.38	104.39	12.48	46.45	54.03	26.16
T_3: DF+ 75 % RDNK	71.30	3.24	22.68	120.00	16.20	55.95	61.95	32.53
T_4: DF+ 100 % RDNK	77.08	3.58	26.12	131.20	19.09	63.08	66.51	37.57
T_5: DF+ 125 % RDNK	78.45	3.62	26.97	133.21	19.81	63.78	67.26	37.78
S. E. (m) ±	1.86	0.10	0.82	3.61	0.62	1.78	1.45	1.08
C. D. at 5%	5.73	0.30	2.45	11.11	1.85	5.49	4.45	3.33

DI-Drip irrigation, DF- Drip fertigation, RDNK-Recommended Dose of N and K

75 per cent fertigation of RDNK ha^{-1} and conventional soil application treatment could not attain the level of significance though higher bulb weight was recorded at 75 per cent level. At harvest, 125 per cent fertigation registered 13.10 per cent gain in fresh bulb weight compared to 100 per cent soil application method. This suggests that split application with higher doses of fertigation was more efficient in increasing fresh bulb weight than the conventional soil application of fertilizers. Kallapa [6] in onionand Mohammad and Zuraiqi [9] also noticed the positive response of N fertigation in increasing fresh weight of garlic compared to conventional method of fertilizer application. From the Table 1. Soil moisture distribution (%) 24 and 48 hrs after drip irrigation at 100 percent pan evaporation in onion, it is indicated that each increment in N and K fertilizer levels given through fertigation resulted significant increase in polar diameter over its preceding lower level.

Maximum polar diameter (63.78 mm) and equatorial diameter (67.26 mm) were observed where 125 per cent recommended dose of N and K was given through fertigation which was closely followed by 100 per cent fertigation of RDNK. Higher polar and equatorial diameter was observed under higher level of fertigation as compared to soil application treatments and lower level of fertigation. Similar results with respect to bulb polar and equatorial diameter were reported earlier by More [10]. Savita *et al*. [14] also reported the significant increase in polar diameter due to fertigation of N and K fertilizers given in splits. This might be due to increased nutrient availability and better uptake and utilization of nutrients as fertigation permits a slow and controlled rate of nutrient application at the root zone of the crop at times when needed which resulted in better growth of onion bulb.

Effect on Onion Bulb Yield

A perusal of the data presented in Table 2 on onion bulb yield (t ha^{-1}) as influenced by different treatmentsindicated that different drip fertigation levels and soil application of fertilizers had a marked and significant influence on onion bulb yield. Drip fertigation at 125 per cent recommended dose of N and K applied through fertigation recorded significantly higher onion bulb yield of 37.78 t ha^{-1} which was followed by 100 per cent fertigation of RDNK ha^{-1}(37.57 t ha^{-1}). Fertigation at 75 per cent N and K ha^{-1} recorded higher, but comparable yield with 100 per cent RDNK ha^{-1} applied through soil indicating 25 per cent fertilizer saving compared to conventional soil application method of applying fertilizers as earlier reported by Savita *et al* [14]. The higher level of fertigation (125 per cent) registered 21.75 per cent increase in onion bulb yield over soil application of fertilizers showing the superiority of fertigation over conventional soil application of fertilizers. Kallapa [6], Vijay kumar *et al.* [17] and Prabhakar *et al* [12] also reported higher onion bulb yield with higher dose of fertigation in onion.

The yield increase was due to higher moisture leading to quick growth, more dry matter production, and higher leaf area due to higher photo assimilation, polar, equatorial diameter and increased bulb size. The significant and marked influence of fertigation over broadcasting method were also reported in earlier studies by Shedeed *et al* [15] in tomato and Ramachandrappa *et al.* [13] in green chilly.

Effect on Bulb Quality Parameters

The quality in onion is an important parameter, which would determine the demand and price in the market. The quality parameters *viz*. total soluble solids, protein percentage and total phenols (Table 3) were significantly improved by drip fertigation with different level of N and K. Drip fertigation with 125 per cent RDNK ha^{-1} recorded the highest TSS of 14.0° Brix and found comparable with 100 per cent RDNK ha^{-1} (13.8° Brix). The highest protein content in bulb (3.65%) was observed in drip fertigation at higher level (125 per cent) closely followed by

Table 3
Bulb quality parameters (TSS,protein percentage, total phenols, water content) as influenced by different treatments

Treatments	*Total soluble solids (%)*	*Protein (%)*	*Total phenols(mg g^{-1})*	*Water content (%)*
T_1: DI +100% RDNK soil application	12.4	2.83	0.36	87.34
T_2: DF+ 50% RDNK	11.6	2.42	0.28	88.04
T_3: DF+ 75 % RDNK	13.1	2.97	0.40	86.50
T_4: DF+ 100 % RDNK	13.8	3.42	0.43	85.44
T_5: DF+ 125 % RDNK	14.0	3.65	0.47	85.13
S. E. (m) ±	0.28	0.13	0.02	0.63
C. D. at 5%	0.87	0.40	0.05	1.79

100 per cent level of RDNK ha^{-1} fertigation. Similar trend in respect of total phenols was registered in this study. The highest water content of bulb was noticed at lower levels of RDNK ha^{-1} than the higher fertigation levels.

TSS values increased with higher fertigation levels of N and K. Fertigation may probably be fulfilled the optimum demand of crop for moisture and their proper utilization. This corresponds to earlier findings of Chopde *et. al.* [2] who reported higher TSS in onion with optimum moisture and fertilizer application. This might also be due to the fact that N has helped in vegetative growth and imparted deep green colour to the foliage, which favored photosynthetic activity of the plants and hence there was greater accumulation of carbohydrates in the bulb which ultimately resulted in more synthesis of TSS content.The beneficial effect of N in protein content and protein yield had been reported by Pandey [11] Kallapa [6]observed the higher protein and phenol content in onion bulb when fertigated with higher levels of fertigation.

CONCLUSION

From the present study, it can be inferred that application of 125 per cent recommended dose of N and K through drip fertigation was found better to register significantly higher growth attributes, yield attributes, onion bulb yield and quality parametersof onion compared to lower levels of N and K fertigation and soil application method. Drip fertigation at 75 per cent recommended dose of N and K ha^{-1} was comparable in relation to growth and yield compared to 100 per cent RDNK ha^{-1} applied through soil by conventional method indicating 25 per cent fertilizer saving through fertigation in onion.

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