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Performance of Mulching and Fertigation on Nutrient Uptake and Nutrient Use Efficiency In Okra (*Abelmoschus Esculentus* L. Moench) for Seed Production

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Abstract

Application of water soluble fertilizer @ T_4-150:75:150 NPK kg/ha through fertigation either with mulch (14.05q/ha) or non-mulch (11.83q/ha) recorded significantly higher seed yield than fertilization through soil application (9.92 q/ha). The increased seed yield of 16.91 and 10.14 percent was noticed in fertigation with mulch or without mulch treatment over soil application, respectively. NPK fertigation @150:75:150kg per ha with mulch (T_4) resulted in higher NPK uptake in stem (63.49, 14.12&121.42 kg/ha), leaves (117.65 19.42 &122.43 kg/ha) and in fruits (146.79 28.05 & 162.66 kg/ha), respectively than the fertilizer applied through soil at harvest. Maximum fertilizer use efficiency and water use efficiency were recorded in the treatment with integrated application of fertigation and mulch.

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Introduction

Okra (*Abelmoschus esculentus* L. Moench), is an important vegetable crop, also known as lady's finger or *bhendi* belongs to family Malvaceae. India stands top in area and production. It is grown in all agro-ecological zones of India mainly for its immature fruits which are eaten as cooked vegetable. Burgeoning population and ever increasing urbanization has boosted the cultivation of vegetables in peri-urban areas in an intensive way. This creates

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a greater demand for quality seeds and it is very much necessary to ensure supply of good quality vegetable seeds. Important inputs *viz.*, water and fertilizer in agriculture are complementary to each other and when used scientifically and judiciously, the production can be increased. Therefore, it is the need of the hour to switch over to the most efficient way of irrigation and fertilizer management. In this context, precision farming technologies including fertigation and polyethylene mulching is known to increase productivity, profitability and nutrient use efficiency in okra seed yield and quality. Fertigation of water-soluble fertilizer need to be given at right dosage and appropriate timing for the precise growth period of the plant. Fertigation in tomato, chilies, cucumber, brinjal, okra, onion, potato, garlic, muskmelon has been practiced to increase the water and nutrient use efficiency, which augmented from 120 to 290 percent.[1] Application of water soluble fertilizers through fertigation showed potential for deeper soil application with a considerable saving ofinput. Consequently quality seed will be the basic prerequisite of any country's food security schemes. The millennium challenge is to produce more food from existing lands. This can be achieved only by using quality seeds of improved high yielding varieties.

The NUE (Nutrient Use Efficiency) in fertigation could be 90 % as compared to 40-60 % in traditional methods of fertilizer application. The quantity of fertilizers lost through leaching would be 10% in the fertigation, however it is 50% in the conventional system of cropping.[2] Fertigation helps in application of a plant nutrient directly at the root zone. Higher nutrient use efficiency depends on time of fertilizer applications on the basis of need, reducing nutrient element losses with traditional application methods and reservoir of soil nutrients.[15] Fertigation is the most efficient and suitable means of maintaining fertility level at optimum level and supply of water according to the specific requirement and the savings in the use of fertilizers to the extent of 25-50 percent.[3] Increase use of agriculture with irrigation and higher use of fertilizers may generate pollution by increased level of nutrients in the underground and surface water. Judicious management of plant nutrients available through different fertilizers needs to be catered. A higher efficiency is possible when a pressurized irrigation system is placed around the roots uniformly which allows rapid uptake of nutrients by the plant. Fertigation is the technique of supplying dissolved fertilizers solution to crops through an irrigation system. Small application of soluble nutrients save labours, reduces compaction in the field, So far not even a single study is available on fertigation and mulching in okra seed production to improve seed quality and quantity. Hence, keeping in view of the facts, a study was taken involving fertigation and mulching for okra seed production and its quality.

Material and Methods

A field experiment was conducted during *Kharif,* 2016 to study the impact of precision farming technologies including fertigation and black polythene mulching in order to estimate the seed yield, nutrient uptake, nutrient use efficiency and water use efficiency in okra var. Arka Anamika at ICAR-IIHR, Hesaraghatta, Bengaluru. Randomized Block Design along with three replications was used for this study. The details of the treatments are given as below:

Treatment Details

T_1-100:50:75 NPK kg per ha through fertigation (WSF)) with mulch

T_2-100:50:100 NPK kg per hathrough fertigation (WSF) with mulch

T_3-150:75:112.5 NPK kg per hathrough fertigation (WSF) with mulch

T_4-150:75:150 NPK kg per hathrough fertigation (WSF) with mulch

T_5-100:50:75 NPK kg per hathrough fertigation (WSF) without mulch

T_6-100:50:100 NPK kg per hathrough fertigation (WSF) without mulch

T_7-150:75:112.5 NPK kg per hathrough fertigation (WSF) without mulch

T_8-150:75:150 NPK kg per hathrough fertigation (WSF) without mulch

T_9-100:50:100 NPK kg per hasoil application of fertilizers without mulch

T_{10}-150:75:150 NPK kg per hasoil application of fertilizers without mulch

WSF-Water Soluble Fertilizer

The experimental plots of 10.2 m (L) x 3.6 m (W) were prepared for sowing the okra seeds. Spacing between rows and plants were 0.60 m and 0.30 m, respectively. Black polythene mulch of 30 micron

thickness was used. Fertilizers *viz.*, 19:19:19, urea and potassium nitrate which are soluble in water and used fertigation treatments, whereas regular NPK fertilizers were applied through soil for the treatments T_9 and T_{10} in the form of DAP and MOP were used in two splits at 28 and 56 days after sowing in equal proportions. The water soluble fertilizers were given in 16 equal splits at 7 days interval and all other recommended cultural practices were followed in raising the crop. Samples of fruit stem and leaves from each plot collected at final at harvest stage of the crop and analyzed for nitrogen content, phosphorus content and potash content. From the results of chemical analysis, nutrient uptake and use efficiency were calculated as indicated below.

Up take of nutrient (kg/ha) = Percent of nutrient concentration x dry matter (kg/ha) / 100

Fertilizer use efficiency of okra fertigation studies was calculated by using the formul [4]

$$\text{Fertilizer Use Efficiency (Kg yield per kg NPK applied)} = \frac{\text{Economic yield (kg per ha)}}{\text{Total NPK applied (kg per ha)}}$$

Water expense efficiency of okra fertigation studies was calculated by using the formula

$$\text{Water use efficiency (kg ha mm}^{-1}\text{)} = \frac{\text{Economic yield (kg per ha)}}{\text{water use (mm)}}$$

Statistical Analysis

The data on growth, seed yield and seed quality parameters were analyzed using the analysis of variance technique.[5] F-test was used for finding significance for treatments. For comparison of treatments means, CD values were analyzed at the probability level of 0.05

Results and Discussion

Application of water soluble fertilizer @ T_4-150:75:150 NPK kg/ha through fertigation either mulch (14.05q/ha) or non-mulch (11.83q/ha) recorded significantly higher seed yield than fertilizer through soil application (9.92 q/ha). The NPK nutrients were analyzed in plant parts on dry matter basis. Application of WSF through fertigation along with mulch in NPK fertigation @150:75:150 kg/ha with mulch (T_4) resulted in highest nitrogen, phosphorus and potassium contents than in conventional method of fertilizer application. Production of okra seeds needs balanced level fertilizer application and adequate supply of nutrients for getting higher quantity of seeds along with quality. Inadequate use of inorganic fertilizers has resulted in lower uptake of nutrients, deterioration of soil health and poor seed quality.[6] It is stated that the growth of the plant, seed yield and seed quality are subject to the availability of a wide range of nutrients present in the soil. Nitrogen is an essential element for growth, development and metabolism of plants. Phosphorus is a second major nutrient and it is constituent of phospholipids, nucleic acid and several enzymes which help in transformation of energy in the plant system.[7] It has beneficial effects on root development, growth and also improves maturity as well as quality of crop produce. Potassium is required by plants for quality of the seed. Potassium helps in disease and vigour resistance to the plant and it helps in higher productivity.[8] The macronutrient uptake of nitrogen, phosphorus and potassium were calculated based on nutrient contents and dry matter production. These factors were responsible for the increase in nutrient uptake by plants at harvest stage. The indeterminate growth habit of the plants also increased in terms of fresh weight and in turn the higher dry matter production leading to increase in total nutrient uptake to meet the metabolic activities of the plant. In the present investigation, the combined treatments of fertigation and mulch resulted higher nitrogen uptake in stem (63.49 kg/ha), leaves (117.65 kg/ha) and in fruits (146.79 kg/ha) at harvest than the fertilizer applied through soil. It could also be owing to the availability of adequate quantity of water supplied on the basis of evapo-transpiration with fertilizers through fertigation for efficient absorption of nitrogen by the plants. Irrigation and fertilizer levels have significant influence on nitrogen uptake by okra crop. In general, uptake was more in fertigation compared to conventional method. In drip irrigation, continuous availability of water and nitrogen through fertigation enhanced the availability of nitrogen to the crop in the root zone, facilitating more uptakes in drip treatments. In conventional method, the uptake of nitrogen was less. This may be due to the lower dry matter production. Significantly higher uptake of phosphorous by various plant parts {stem (14.12 kg/ha), leaves (19.42 kg/ha) and fruits (28.05 kg/ha)}

were seen in the combined application offertigation and mulching (T_4) as compared to fertilizer applied through soil. The highest uptake of phosphorus was found in fruits followed by leaves and stem. Higher uptake of phosphorus could be due to the fact that the fertigation may be attributed to the direct addition of P at root zone as well as solubilization of native P through release of various organic acids. Similar improvement in available P status due to integrated use of manures and fertilizers.[9] The potassium uptake of leaves (121.42 kg/ha), stem (122.43 kg/ha) and fruits (162.66 kg/ha) was higher than all other elements at harvest, which indicates that the potassium is the most required nutrient for production of quality seeds in okra. Higher dose of potassium through WSF through fertigation with mulch resulted in higher potassium content in leaves, stem and fruits in both first and second year field experiments. Higher amount of nitrogen and potassium required for vegetative growth, flowering and pod formation in okra. Significantly increase in total N and K uptake by application of higher level of nitrogen and potassium.[9&10]

The pooled data indicated that the combined application of fertigation and mulch resulted in higher fertilizer use efficiency than the WSF through fertigation without mulch and fertilizers through soil application. Among treatments, for production of one kg okra seed the requirement of NPK was worked out to be 3.83 kg in the treatment NPK fertigation @150:75:150kg per ha with mulch (T_4) as compared to NPK fertigation @ 150:75:150kg per ha without mulch (T_8-3.09 kg of NPK) and 2.62 kg of NPK was the requirement in NPK soil application @ 150:75:150kg per ha. Fertigation with NPK fertigation @150:75:150kg per ha with mulch (T_4) resulted higher nutrient use efficiency of 19 and 31 percent over fertigation without mulch and fertilizer through soil. It may be due to supply of nutrients directly at the root zone and quick availability of moisture.[11, 12, 13&14] Fertigation can save 20 to 30 percent of fertilizers, besides improving the yield and quality as compared to the traditional methods of fertilizer application[15] Teixeira *et al.,*[16] reported that application of nitrogen and potassium through fertigation resulted in increase of 36 percent in nutrient use efficiency compared to conventional method of fertilizer application. Higher nutrient use efficiency contributed to reduction in the requirement of fertilizers and cost of cultivation. Similarly drip fertigation treatments recorded higher water use efficiency compared with fertigation and soil applied fertilizer treatments. The combined application of fertigation and mulch in treatment NPK fertigation @150:75:112.5kg per ha with mulch (T_3) and NPK fertigation @150:75:150kg per ha with mulch (T_4) resulted with 3.51 kg ha-mm^{-1} higher WUE than the NPK fertigation @ 150:75:150kg per ha without mulch (T8-2.93 kg ha-mm^{-1}) as well as NPK soil application @ 100:50:100kg per ha (T9-2.18 kg ha-mm^{-1}) as observed from both years of field experiment. This is in line with the findings of Soumya *et al.,*[17] and Mahendran *et al.,*[18] In general NPK fertigation through water soluble fertilizer with mulch (2.94-3.51 kg ha-mm^{-1}) resulted in relatively higher use efficiency over fertigation without mulching (2.55-2.96 kg ha-mm^{-1}) and fertilizer through soil application (2.18-2.48 kg ha-mm^{-1}).

Conclusion

Application of fertilizer through fertigation along with mulch @150:75:150kg per ha with mulch (T_4) resulted highest nitrogen, phosphorus and potassium contents than conventional method of fertilizer application. Similarly higher uptake of nitrogen, phosphorous and potassium by various plant parts were recorded in the combined treatment comprising fertigation and mulching compared to fertilizer applied in soil.

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Conflict of Interest

The authors do not have any conflict of interest.

References

1. Singh P.K., Singh D.R., and Ved Byas Singh. Effect of nitrogen, phosphorus and bio-fertilizer (*Azoto bacter*) on growth, yield and quality of okra. *Indian J. Hort*. 2010 67;477-478.
2. Sivanappan, R.K. 1985. In: Drip irrigation in action, vol. II ASAE, Michigan, pp-736-740.
3. Haynes, R.J. 1985. Principles of fertilizer use for trickle irrigated crops. *Ferti. Res.* 6(3):235-255.
4. Veeranna, H. K. Abdul khalak, A.A., Farooqui, G.M., and Sujith. Effect of fertigation, irrigation and potassium levels on the productivity of chilli (*Capsicum annuum* L.). Ph. D. Thesis, 2000. University of Agri. Sci, Bangalore.
5. Sundaraja, N., Nagaraju, M.N., Venkataramu, and Jaganath, M.K. Design and analysis of field experiments, 1972. UAS and biostat-IIHR Bangalore.
6. Kale, R.N., Bano, K., and Satyavati, G.P. Final report of KSCST project N-67-04/Vermi./34 B(3478). *Agri. Res*,1991. 23(1):164-167.
7. Yawalakar, K.S., Agrwal, J.P., and Bokde, S., Manures and fertilizer 1962. Agri-horticultural publishing house, Nagpur, 440010, India.
8. Mandal, P.N., Singh, K.P., Singh, V.K., and Roy, R.K. Effect of production and plant growth regulators on quality and economics of hybrid okra [*Abelmoschus esculentus* (L.) Moench], *Adv. Res. J Crop improve.,* 2012: 3:5-7.
9. Balle Gowda, M.C., Krishnappa, K.S.,ChandreGowda, M.,andPuttaraju,T.B. Effect of NPK levels on dry matter, nutrient accumulation and uptake of nutrients in okra. *South Indian Hort,* 2002:50 (4-6): 543-549.
10. Sharma, T.R., Pandey, A.K., Upadhyaya, S.D.,andAgarwal, S.B.Effect of sources of nutrients and their levels on yield, quality and economics of summer season okra. *Indian J of Hortic.*,2011:68 (4): 498-502.
11. Sukruth Kumar, T., Sanjeevareddy, N., Singa Rao, M., and Mahadevappa, S.G. Effect of fertigation in okra in distribution of moisture in soil profile and WUE compared to conventional method in alfisols. *Prog. Res.*, 2013:(8):510-515.
12. Puneet Sharma, and Arun Kaushal. Growing okra with drip fertigation-a review. *Inter. J. Engg. Sci. Inven*., 2015:4(9): 2319 – 6734.
13. Anu Varughese J. S., Menon, and Mathew, E. K. Effect of fertigation levels and drip system layout on performance of okra under plastic mulch. *J. Agril. Engg*, 2014;51 (4): 28-32.
14. Kadam, D.B., Kasture, M.C., Dodake, S.B., Dhopavkar, R.V., and Dademal, A. A. Effect of boron and Konkanannapurna briquettes on yield, nitrogen use efficiency and nutrient uptake by okra (*Abelmoschusesculentus*(L.) IJCS, 2017: 5(3): 214-217.
15. Mustaffa, M. M., and Kumar, V. Banana production and productivity enhancement through spatial, water and nutrient management. *J. Hort. Sci.,* 2012:7(1):1-28.
16. Teixeira, L.A.J., Quaggio, J.A., and Mellis, E.V., Enhancing nutrient use efficiency in banana due to irrigation and fertigation. *Revista Brasileira de Fruticultura*, 2011:33(1): 272-278.
17. Soumya, T. M., Ramachandrappa, B.K., and Nanjappa, H.V. Effect of fertigation with different sources and levels of fertilizer on growth and yield of tomato. *Mysore J. Agril. Sci.*,2008. 43 (1): 80-84.
18. Mahendran, P.P., Arunkumar, D., Gurusamy, A., and Kumar, V. Performance of nutrient sources and its levels on hybrid *bhendi* under drip fertigation system. In: Innovation in technology and management of micro-irrigation for crop production enhancement. 8th International Micro-irrigation Congress under 21st International Congress on Irrigation and Drainage, 16-21 October 2011, Tehran, Iran.