Biological Forum – An International Journal **13(3a): 653-656(2021)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Effect of Spacing and Nitrogen Management on Growth and Yield of Quinoa (*Chenopodium quinoa* L.)

Karasani Rajasekhar Reddy[1*], Rajesh Singh[2] and Ektha Singh[3]

[1]M.Sc. Scholar, Department of Agronomy, NAI, SHUATS, Prayagraj-211007, (Uttar Pradesh), India.
[2]Assistant Professor, Department of Agronomy, NAI, SHUATS, Prayagraj-211007, (Uttar Pradesh), India.
[3]Ph.D. Scholar, Department of Agronomy, NAI, SHUATS, Prayagraj-211007, (Uttar Pradesh), India.

(Corresponding author: Karasani Rajasekhar Reddy)*
(Received 26 July 2021, Accepted 29 September, 2021)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: A field trial was conducted during *Rabi* 2020 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P.). The soil was sandy loam in texture, approximately neutral in soil reaction (pH 7.1), low in organic carbon (0.36%), available Nitrogen (171.48 kg/ha), available Phosphorus (15.2 kg/ha) and available potassium (232.5 kg/ha). The treatments which are spacing of 20 × 10 cm, 25 × 10 cm and 30 × 10 cm+ 100% RDN, 75%, 50% RDN through N+ 25%, 50% RDN by Vermicompompost + Azotobacter inoculation used. The trial was laid out in Randomized Block Design with 9 treatments each replicated thrice. The results revealed that plant height (122.13 cm), maximum dry weight (21.64 g), CGR (8.08 g/m^2/day) and RGR (0.01) were recorded significantly in T_8 which is with spacing of 30 × 10 + 75 % RDN + 25 % N through VC + Azotobacter inoculation. The maximum no. of seeds/panicle (5957.36), grain yield (19.46 t/ha), test weight (2.05 g) and stover yield (23.34 t/ha) were recorded in the treatment T_8 which is with spacing of 30 × 10 cm + 75% RDN through N + 25% RDN by Vermicompost + Azotobacter inoculation as compared to all other treatments.

Keywords: Spacing, Nitrogen management, growth, Yield, Vermicompost and Azotobacter.

INTRODUCTION

Quinoa (*Chenopodium quinoa*) is a pseudo cereal crop and belongs to Chenopodiaceae family. Quinoa is discovered healthy food by North Americans and Europeans in the 1970's and its popularity is dramatically increased in recent years because it is gluten free (helpful for diabetic patients) and high in protein. These plants grow up to 1-2 meter tall with deep penetrating roots. Quinoa has greater plasticity of adaption to photoperiod, altitude, soil pH etc., (Simmonds, 1971). It is annual broad leaved plant also adoptable to the conditions of marginal lands (Rea *et al.,* 1979). Quinoa is an a chene with diversified colour alternating from white or pale yellow to orange, red, brown and black.

Quinoa grains contain essential amino acids, particularly methionine, threonine and lysine, which are the limiting amino acids in most of the cereal grains (Comai *et al*., 2007). The organization of the United Nations for Food and Agriculture (FAO) has declared the year 2013 as the year of quinoa (Anonymus, 2013). In India, quinoa was cultivated in an area of 440 hectares with an average yield of 1053 tonnes (Srinivasa Rao, 2015).

Crop geometry is one of the important factors which have to be maintained at optimum level to harvest maximum solar radiation and utilize the soil resources effectively. As plant density increases the grain yield improves to a maximum, which remains constant within a range and declines more or less, steeply as population pressure increases still further.

Vermicomposting is an effective means of composting the decomposable organic wastes using earthworms and its nutrient level 1-1.5%N, 0.6-0.8%P and 1.2-1.5% Vermicomposting is an effective means of composting the decomposable organic wastes using earthworms and its nutrient level 1-1.5% N, 0.6-0.8% P and 1.2-1.5%.

Vermicomposting involve biological decomposition of organic waste to produce a stabilized organic fertilizer. However, vermicomposting is distinguished from all other pollution control processes, including composting, in that an animal—an earthworm—facilitates the microbial action on the waste. This occurs because the waste is exposed to certain bacteria and enzymes present in the earthworm gut which are not available during composting or other biological degradation processes and which bestow special attributes to a vermicompost (Hussain *et al*., 2018).

Vermicomposting is an effective means of composting the decomposable organic wastes using earthworms and its nutrient level 1-1.5% N, 0.6-0.8% P and 1.2-1.5%. Bio fertilizer, an alternate low cost resource have gained prime importance in recent decades and play a vital role in maintaining long term soil fertility and

sustainability. They are cost effective, eco-friendly and renewable sources of plant nutrients to supplement chemical fertilizers. Azotobactor has been recognized as an important diazotoph colonizing root environment of cereal crops. It fixes atmospheric nitrogen, 25-30 kg/ha (Singh *et al*., 2015). Bio fertilizers are the preparations which contain living cells of efficient strains of various microorganisms that enhance uptake of nutrients by their interaction in the rhizosphere when applied through soil or seed treatment. Bio fertilizers add nutrients in soil through the natural processes of nitrogen fixation, solubilizing phosphorus, and stimulating plant growth through the synthesis of growth promoting substances (Kumar *et al*., 2020).

MATERIALS AND METHODS

A field trial was conducted during Rabi season 2020 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P.) during Kharif season 2020.The soil was sandy loam in texture, low in organic carbon and medium in available nitrogen, phosphorous and low in potassium. Nutrient sources were Urea, DAP, MOP to fulfill the requirement of Nitrogen, phosphorous and potassium. The treatments which are withT_1 – 20 × 10 cm + 100 % RDN, T_2 – 20 × 10 cm + 75 % RDN + 25 % N through VC + Azotobacter, T_3 – 20 × 10 cm +50 % RDN + 50 % N through VC + Azotobacter, T_4 – 25 × 10 cm + 100 % RDN, T_5 – 25 × 10 cm +75 % RDN + 25 % N through VC + Azotobacter, T_6 – 25 × 10 cm +50 % RDN + 50 % N through VC + Azotobacter, T_7 - 30×10 + 100 % RDN, T_8 – 30 × 10 +75 % RDN + 25 % N through VC + Azotobacter, T_9 – 30 × 10 +50 % RDN + 50 % N through VC + Azotobacter used. The Experiment was laid out in Randomized Block Design, with 9 treatments each replicated thrice. Date of sowing was on 10th December 2020 with the seed rate of 15 kg/ha. In the period from germination to harvest several plant growth parameters were recorded at frequent intervals along with it after harvest several yield parameters were recorded those parameters are growth parameters, plant height and plant dry weight are recorded. The yield parameters like seeds per panicle, grain yield, test weight (1000 seeds), stover yield and harvest index were recorded and statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Effect on growth of quinoa. The statistical data regarding growth parameters is presented in Table 1.

Table 1: Effect of Spacing and Nitrogen Management on growth parameters of quinoa

Treatments	Plant height (cm)	Dry weight (g/plant)	C.G.R (g/m^2/day)
T_1 - 20 × 10 cm + 100 % RDN	109.07	20.41	8.08
T_2 – 20 × 10 cm + 75 % RDN + 25 % N through VC + Azotobacter	116.70	20.91	7.64
T_3 – 20 × 10 cm + 50 % RDN + 50 % N through VC + Azotobacter	115.80	20.75	7.77
T_4 – 25 × 10 cm + 100 % RDN	111.30	20.52	6.24
T_5 – 25 × 10 cm + 75 % RDN + 25 % N through VC + Azotobacter	120.87	21.37	6.50
T_6 – 25 × 10 cm + 50 % RDN + 50 % N through VC + Azotobacter	117.70	21.19	6.34
T_7 - 30 × 10 + 100 % RDN	113.17	20.62	5.17
T_8 – 30 × 10 + 75 % RDN + 25 % N through VC + Azotobacter	122.13	21.64	5.33
T_9 – 30 × 10 + 50 % RDN + 50 % N through VC + Azotobacter	121.23	21.53	5.50
S. EM (±)	**0.38**	**0.13**	**0.27**
CD (5%)	**1.15**	**0.40**	**0.80**

Plant height (cm). Highest plant height (122.13 cm) was recorded in T_8 with spacing of 30 × 10 cm + 75% RDN + 25% nitrogen through Vermicompost + Azotobacter inoculation. Increasing spacing resulted in lesser competition for sun light, water, nutrients and space between the plants which resulted in higher plant height and due to the inoculation of bacterial preparation accelerate plant growth provide biologically fixed nitrogen to the inoculated plant, and also supply of nitrogen through inorganic and organic means promoted the increase in plant height. Similar results was observed by Ramesh *et al.,* (2017); Wagh, (2002).

Dry weight (g). Significantly maximum plant dry weight (21.64g) was recorded in treatment T_8 with spacing of 30 × 10 cm + 75% RDN + 25% nitrogen through Vermicompost + Azotobacter inoculation. The probable reason for increase in dry weight might be due to better photosynthetic activity, due to greater exposure of sunlight and increased availability of nutrients and large portion of nitrogen in Vermicompost in organic fractions and application of RDF through inorganic means resulted in higher concentration of nutrients in plant results in higher dry matter accumulation. The results were in accordance to the findings of Olofintoye *et al*., (2015); Aparna *et al*., (2019).

Crop Growth Rate (g/m^2/day). At 80 DAS-harvest, the significant increase in CGR (8.08 g/m^2/day) was recorded in T_1 with spacing 20 × 10 cm + 100% RDN, the CGR was significantly higher with closer crop geometry of 20 × 10 cm all the growth stages, which was mainly due to more population per unit area Prommarak, (2014).

Effect on yield and yield attributes of quinoa. The statistical data representing yield and yield attributes is presented in Table 2.

Table 2: Effect of Spacing and Nitrogen Management on yield parameters and yield of Quinoa.

Treatments	Number of seeds/panicle	Grain yield (q/ha)	Stover yield (q/ha)	Test weight (g)	Harvest index (%)
T_1 - 20 × 10 cm + 100 % RDN	4334.57	13.99	18.17	1.62	43.50
T_2 – 20 × 10 cm +75 %RDN + 25 % N through VC + Azotobacter	5020.61	15.47	19.23	1.76	45.46
T_3 - 20× 10 cm +50 %RDN + 50 % N through VC + Azotobacter	4781.67	14.67	18.51	1.69	44.93
T_4 - 25×10 cm + 100 % RDN	4676.33	13.35	17.41	1.66	43.38
T_5 - 25× 10 cm +75 %RDN + 25 % N through VC + Azotobacter	5672.61	18.40	21.94	1.80	45.59
T_6 - 25×10 cm +50 %RDN + 50 % N through VC + Azotobacter	5353.67	17.18	21.30	1.94	44.65
T_7 - 30 × 10 + 100 %RDN	5134.38	12.85	16.69	1.72	43.50
T_8 - 30 ×10 +75 %RDN + 25 % N through VC + Azotobacter	5957.36	19.46	23.34	2.05	44.58
T_9 - 30 × 10 +50 %RDN + 50 % N through VC + Azotobacter	5766.42	18.91	23.18	1.99	44.20
F test	**S**	**S**	**S**	**S**	**S**
Sem (+)	**98.23**	**0.37**	**0.42**	**0.04**	**0.41**
CD (5%)	**294.51**	**1.12**	**1.26**	**0.11**	**1.23**

Treatment T_8 with spacing of 30 × 10 cm + 75% RDN + 25% nitrogen through Vermicompost + Azotobacter inoculation was recorded significantly higher number of seeds per panicle (5957.36) and T_8 with spacing of 30 × 10 cm + 75% RDN + 25% nitrogen through Vermicompost + Azotobacter inoculation was recorded significantly higher test weight (2.05 g). Significant increase in number of seeds/panicle is due to increase in the availability of Nitrogen through bio fertilizer inoculation by which more seeds/panicle are produced due to increased rates of panicles primordial production, similar results were found Fazily *et al.,* (2021).

Treatment T_8 with spacing of 30 ×10 cm + 75% RDN + 25% nitrogen through Vermicompost + Azotobacter inoculation was recorded significantly higher grain yield (19.46 q/ha) was at par with treatment T_5 and T_9 over all the treatments. Increase in grain yield might be due to under 30 × 10 cm because the less intra row spacing in other treatments increases competition in solar radiation that ultimately stunt growth of some intra row plant in vegetative phase and they were unable to reach reproductive phase even though the yield contributing variables were high when compared to the recommended spacing, the productivity was low due to the lesser plant population reached to reproductive phase. The findings were in accordance with Ciftci *et al.,* (2020).

Whereas, significantly maximum stover yield (23.34 q/ha) is recorded in treatment T_8 with spacing of 30 × 10 cm + 75% RDN + 25% nitrogen through Vermicompost + Azotobacter inoculation. This positive effect might be due to the fact that nitrogen is well known for its role in development and growth of plant and in various vitally important metabolic processes in the plant, the positive results of RDF and vermicompost application helped in increase of plant growth which led to higher stover yield. The similar findings were found by Himanshi and Shroff (2020). Whereas, treatment T_5 with spacing of 25 × 10 cm +75 % RDN + 25 % N through VC +Azotobacter inoculation was recorded significantly higher harvest index (45.59 %).

CONCLUSION

On the basis of one season of experimentation with of spacing with 30 × 10 cm + 75% RDN+ 25% nitrogen through Vermicompost + Azotobacter inoculation was found more beneficial in terms of growth and yield parameters of quinoa suitable to grow under eastern Uttar Pradesh Conditions.

FUTURE SCOPE

Since, the findings were based on the research done in one season under agro-ecological conditions of prayagraj it may be repeated for confirmation and farmer recommendations.

Acknowledgement. I express gratitude to my advisor Dr. Rajesh Singh and all the faculty members of Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj -211007, Uttar Pradesh. For providing us essential facilities to undertake the studies.

Conflict of Interest. Nil.

REFERENCES

Aparna, K., Rekha, B. K., Vani, K. P., & Prakash, T. R. (2019). Growth and yield of finger millet as influenced by crop residue composting. *Journal of Pharmacognosy and Phytochemistry, 8*(4): 1108-1111.

Anonymus (2013). Cereals of mother: Quinoa, *Journal of Tubitak Science and Technology*, *54*(7): 34-35.

Ciftci, S., Zulkadir, G., Gokce, M. S., Karaburu, E., Bozdag, E., & Idikut, L. (2020). The Effect of Row Distances on Quinoa Yield and Yield Components in the Late Planting Period. *International Journal of Research Publication and Reviews*, *1*(4): 37-42.

Comai, S., Bertazzo, A., Bailoni, Zancato, L. M., Costa, C. V. L., & Allegri, G. (2007). The content of proteic and nonproteic (free and protein bound) tryptophan in Quinoa and cereal flours. *Food Chemical, 100*: 1350-1355.

FAOSTAT (2013). Quinoa area and production in the World. http://www.fao.org

Fazily, T., Thakral, S. K., & Dhaka, A. K. (2021). Effect of Integrated Nutrient Management on Growth, Yield Attributes and Yield of Wheat. *International Journal of Advances in Agricultural Science and Technology, 8*(1): 106-118.

Himanshi, H. P., & Shroff, J. C. (2020). Growth, Yield and Economics of Finger millet [*Eleusine coracana* (L.) Gaertn] as Influenced by Integrated Nutrient Management. *International Journal of Current Microbiology and Applied Sciences*, *11*: 724-729.

Hussain, N., & Shahid A. Abbasi (2018). Efficacy of the Vermicomposts of Different Organic Wastes as "Clean" Fertilizers: *State-of-the-Art. Sustainability*, *10*: 1205.

Olofintoye, J. A. T., Abayomi, Y. A., & Olugbemi, O. (2015). Yiled response of grain amaranth (*Amaranthus cruentus* L.) varieties to varying planting density and soil amendment. *African Journal of Agricultural Research*, *10*(21): 2218-2225.

Prommarak, S. (2014). Response of quinoa to emergence test and row Spacing in Chiang Mai-Lumphun valley Lowland Area. *Khon Kaen Agricultural Journal*, *42*(2): 8-14.

Ramesh, K., Suneetha Devi, K. B., Gopinath, K. A., & Devi, M. U. (2017). Growth, Yield and Economics of Quinoa as Influenced by Different Dates of Sowing and Varied Crop Geometry. *International Journal of Pure Applied Bioscience*, *5*(6): 849-854.

Singh, R. K., Kumar, P., Prasad, B., & Singh, S. B. (2015). Effect of biofertilizers on growth, yield and economics of rice (*Oryza sativa* L.). *International Research Journal of Agricultural Economics and Statistics*, *6*(2): 386-391.

Rea, J., Tapia, M., Mujica, A., Gandarillas, H., Alandia, S., & Cardozo, A. (1979). Practicas agronomicas. In: Quinoa Kaniwa, *Cultivos Andinos,*. *FAO, Rome*, Italy: 83-120.

Kumar, S., Sewhag, M., Shweta, Uma Devi & Neelam (2020). Growth and Phenology of Barley as Influenced by Various Nutrient Management Practices. *International Journal of Current Microbiology and Applied Sciences*, *9*(7): 3920-3927.

Simmonds, N.W. (1971). The breeding system of *Chenopodium quinoa*. *Male Sterility, Heredity*, *27*: 73-82.

Srinivasa Rao, K. (2015). Sarikothapanta quinoa, Sakhi News Paper page:10 on 11.08.2015.

Wagh, D. S. (2002). Effect of spacing and Integrated Nutrient Management on Growth and Yield of Sweet Corn (*Zea mays saccharata*). *M.Sc. (Agri.) Thesis*, Mahatma Phule Krishi Vidyapeeth, Rahuri, Distt. Pune.

How to cite this article: Reddy, K.R., Singh, R. and Singh, E. (2021). Effect of Spacing and Nitrogen Management on Growth and Yield of Quinoa (*Chenopodium quinoa* L.). *Biological Forum – An International Journal*, *13*(3a): 653-656.