International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(1): 1118-1122

Received: 18-11-2017
Accepted: 19-12-2017

Umesh Chandra Sati,
Department of Vegetable Science, College of Agriculture, G.B.P.U.A.&T., Pantnagar, Uttarakhand, India

Manoj Raghav
Professor, Department of Vegetable Science, College of Agriculture, G.B.P.U.A.&T., Pantnagar, Uttarakhand, India

Durvesh Kumar Singh
Professor, Department of Vegetable Science, College of Agriculture, G.B.P.U.A.&T., Pantnagar, Uttarakhand, India

Sobaran Singh
Professor, Department of Soil Science, College of Agriculture, G.B.P.U.A.&T., Pantnagar, Uttarakhand, India

Dhananjay Kumar Singh
Professor, Department of Agronomy, College of Agriculture, G.B.P.U.A.&T., Pantnagar, Uttarakhand, India

Dhirendra Kumar Singh
Professor, Department of Vegetable Science, College of Agriculture, G.B.P.U.A.&T., Pantnagar, Uttarakhand, India

Correspondence
Umesh Chandra Sati
Department of Vegetable Science, College of Agriculture, G.B. Pant University of Agriculture & Technology, Pantnagar- 263 145, Uttarakhand, India

Integrated nitrogen management in okra under *Tarai* conditions of Uttarakhand

Umesh Chandra Sati, Manoj Raghav, Durvesh Kumar Singh, Sobaran Singh, Dhananjay Kumar Singh and Dhirendra Kumar Singh

Abstract
The present investigation carried out to examine the effect of on growth and yield of okra at Vegetable Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand in summer seasons of 2016 and 2017 with fourteen treatments containing different combinations of organic and inorganic sources of nitrogen replicated thrice. Observations for growth parameters *viz.*, plant height, stem diameter and number of leaves per plant at different growth stages of plants, leaf area index and the total marketable yield of green pods were recorded. The findings of two year investigation revealed that the performance of okra crop was significantly influenced by various treatments. Among all treatments, treatment T_6 (RDN- 75% through neem coated urea + 25% through vermi-compost) was found best with respect to plant growth and yield and hence, recommended for obtaining higher yield of okra under prevailing climatic conditions of Uttarakhand *tarai* region.

Keywords: growth, marketable yield, neem coated urea, okra, vermicompost

Introduction
Okra is an important annual vegetable crop grown in tropical and sub-tropical parts of the world mainly for its tender green fruits used as vegetable. It is rich in vitamins, calcium, potassium and other minerals. Besides, being a short duration hardy vegetable crop, it is also known for its nutritional and medicinal importance. It can be grown throughout the country in different agro-climatic zones and has the potential to improve food security. Despite of its nutritional richness, it has not yet attained the optimum yields because of a continuous decline in the fertility of soil (Ogundare *et al.*, 2015) [10] which could be attributed to imbalanced use of fertilizers in our country. Among nutrients required for adequate nutrition and high yield of okra, nitrogen (N) is the most critical. It has its main role in contributing to the plant growth characters thereby influencing the yield and quality parameters which are generally directly correlated to each other. Unfortunately, N deficiency is widespread in India on account of low available soil N and organic matter content as a result of nitrification and leaching losses. Imbalanced application of urea for obtaining higher yields has reduced the fertility of the soil. In initial years, it may be higher production of crops but simultaneously affects the production capacity of the land and after successive years, farmers get low production. Applications of neem coated urea (NCU) and organic manures have been proved to be an effective natural way to reduce the nitrification and leaching losses. However, there is not much research being done in vegetable crops to compare the use of normal urea and neem coated urea and their use in combination with organic manures.
Now-a-days, soil test crop response (STCR) based fertilizer recommendation approach is also being used for estimation of fertilizer nutrient for profitable response (Goswami, 2006) [7] which further also provides an idea about the fertilizer need based on yield, nutritional requirement of crop as well as soil nutrient status after harvest (Ramamoorthy *et al*., 1967) [16]. Keeping all this in view, in order to study the effect of organic and inorganic nitrogen sources on growth, yield and quality of okra, the present experiment was conducted under *tarai* conditions of Uttarakhand.

Materials and Methods
The fieldwork carried out at Vegetable Research Centre, G.B. Pant University of Agriculture and Technology, Pantnagar, District- Udham Singh Nagar, Uttarakhand during the summer seasons of year 2016 and 2017. The soil of the experimental plot was sandy loam with neutral

pH (7.35 and 6.90) and low available nitrogen (151.8 and 165.12 kg/ha), phosphorus (28.5 and 29.91 kg/ha) and potash (168.35 and 181.72 kg/ha), respectively during both the years. The experiment laid out in Randomized Block Design with three replications consisting fourteen treatments with recommended dose of nitrogen (RDN) *viz.*, T_1 (Control), T_2 (RDN- 50% VC + 50% FYM), T_3 (RDN- 100% Urea), T_4 (RDN- 100% NCU), T_5 (RDN- 75% Urea + 25% VC), T_6 (RDN- 75% NCU + 25% VC), T_7 (RDN- 75% Urea + 10 t/ha FYM), T_8 (RDN- 75% NCU + 10 t/ha FYM), T_9 (RDN- 100% Urea + 2.5 t/ha VC), T_{10} (RDN- 100% NCU + 2.5 t/ha VC), T_{11} (RDN- 100% Urea + 5 t/ha FYM), T_{12} (RDN- 100% through NCU + 5 t/ha FYM), T_{13} (STCR with organic) and T_{14} (STCR without organic). Organic manures used in the experiment *viz.*, FYM (0.57% N, 0.32% P_2O_5 and 0.52% K_2O) and vermicompost (1.61% N, 1.17% P_2O_5 and 1.84% K_2O) were applied one week before sowing of seeds. The recommended dose of fertilizers given were 100:40:40 kg NPK/ ha from which full dose of P_2O_5 and K_2O applied in all treatments (except T_2 and STCR treatments) as basal while, nitrogen doses were applied as per treatments in two equal splits *i.e.*, half as basal and half as top-dress at 30 DAS. Treatment T_2 applied fully as organic while, the soil test-based crop response (STCR) treatments applied with 20 t/ha FYM (only in treatment STCR with organic), nitrogen (neem-coated urea) in two equal splits, phosphorus (SSP) and potassium (MOP) after working out the doses required as per calculations made with the equations suggested for Mollisol soils by Rawat *et al*. (2015) [18].

The seeds of okra cv. Parbhani Kranti were sown after proper seed treatment in each plot (net size 3.0 m x 2.25 m) with two seeds per hill at spacing of 45x30 cm row-to-row and plant-to-plant maintaining 50 plants per plot later after thinning.

Observations for growth parameters *viz.*, plant height, stem diameter and number of leaves per plant were recorded at 30, 60 and 90 days after sowing (DAS) while, leaf area index was recorded at 60 DAS, while, marketable green pod yield was recorded by summing up marketable yields of each picking as a yield parameter. The data was subjected for analysis of variance (ANOVA) as per the method suggested by Panse and Sukhatme (1967) [11].

Results and discussion

Growth parameters

Plant height

The data on plant height (**Table 1**) revealed that okra was significantly affected by various nitrogen treatments. During both the years and pooled analysis over the years, treatment T_6 (RDN- 75% NCU + 25% VC) recorded the maximum plant height at all stages of crop growth. A critical analysis of the data indicated that the recommended dose of nitrogen in the form of neem coated urea along with organic manure increased the plant height in comparison to control and sole application either as organic manure or inorganic fertilizer. An increase in plant height with combined application of inorganic and organic sources might be due to the fact that the soil of experimental plot was low in available nitrogen and the application of combined sources improved the soil nitrogen status which resulted in better growth of plant in comparison to control. Similar results were also reported by Das *et al.* (2014) [6] and Jaja and Ibeawuch (2015) [8] who reported significant increase in plant height with the combined application of inorganic and organic sources as compared to control and sole application of inorganic fertilizers. Kumar *et al.* (2010) [1] also reported significantly higher growth in case of aromatic rice with the application of urea coated with neem oil as compared to uncoated prilled urea.

Table 1: Effect of various organic and inorganic treatments on plant height of okra

Treatments	Plant height (cm)								
	30 DAS			60 DAS			90 DAS		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
T_1	13.2	13.9	13.5	35.9	33.4	34.6	61.1	56.0	58.6
T_2	15.8	14.2	15.0	49.0	34.1	41.5	77.8	63.3	70.6
T_3	19.6	20.5	20.1	60.9	49.2	55.1	96.8	94.5	95.6
T_4	21.3	21.7	21.5	63.3	52.0	57.7	100.5	99.8	100.2
T_5	20.6	19.2	19.9	61.8	46.0	53.9	97.6	89.1	93.3
T_6	24.1	22.9	23.5	64.2	54.4	59.3	107.4	104.5	106.0
T_7	20.5	21.8	21.2	61.6	52.4	57.0	97.1	100.6	98.9
T_8	20.9	20.0	20.4	62.7	48.0	55.3	99.8	92.1	95.9
T_9	17.8	18.8	18.3	58.0	45.1	51.5	95.7	86.9	91.3
T_{10}	21.4	20.7	21.0	63.7	49.5	56.6	101.3	95.1	98.2
T_{11}	18.7	18.9	18.8	60.5	45.5	53.0	96.5	87.4	91.9
T_{12}	20.8	20.5	20.7	62.4	49.3	55.8	98.1	94.6	96.3
T_{13}	20.5	20.2	20.4	61.4	48.4	54.9	96.9	93.2	95.1
T_{14}	18.1	18.8	18.5	58.5	45.5	52.0	95.8	87.4	91.6
SEm±	1.3	1.3	1.1	2.9	2.8	1.8	4.8	6.1	3.9
C.D. (0.05)	3.9	4.0	3.4	8.6	8.3	5.3	14.0	17.9	11.4

Stem diameter

The data (Table 2) clearly indicates that stem diameter of okra was significantly affected by various nitrogen treatments however, at 30 DAS in the second year, it was found not affected. Treatment T_6 (RDN- 75% NCU + 25% VC) during both the years and pooled analysis over the years recorded the maximum stem diameter. The results depicted from the data revealed that the application of recommended dose of nitrogen through neem coated urea along with vermicompost significantly increased the stem diameter of okra plants as compared to control and other treatment combinations. It might be due to slow and continuous release of nitrogen from neem coated urea and vermicompost (on decomposition) which resulted in increased stem diameter as compared to the control and other treatment combinations. Increase in stem diameter might also be due to increased plant growth due to large increase in soil microbial biomass after vermicompost applications, leading to the production of hormones or humic acids in the vermicompost which act as plant growth regulators independent of nutrient supply (Arancon *et al.*,

2003) [2]. Similar results were reported by Attarde *et al.* (2012) who found that combination of organic and inorganic fertilizers was beneficial for the physical growth of okra plant.

Table 2: Effect of various organic and inorganic treatments on stem diameter of okra

Treatments	Stem diameter (cm)								
	30 DAS			60 DAS			90 DAS		
	2016	2017	P	2016	2017	P	2016	2017	P
T_1	0.60	0.68	0.64	1.16	1.21	1.18	1.73	1.87	1.80
T_2	0.56	0.70	0.63	1.40	1.45	1.42	2.03	2.16	2.09
T_3	0.64	0.76	0.70	1.50	1.53	1.51	2.17	2.57	2.37
T_4	0.67	0.77	0.72	1.53	1.57	1.55	2.21	2.58	2.40
T_5	0.60	0.76	0.68	1.71	1.72	1.71	2.50	2.71	2.61
T_6	0.68	0.78	0.73	1.85	1.96	1.90	2.80	3.00	2.90
T_7	0.56	0.71	0.64	1.44	1.48	1.46	2.11	2.21	2.16
T_8	0.67	0.75	0.71	1.53	1.55	1.54	2.24	2.46	2.35
T_9	0.59	0.74	0.66	1.70	1.74	1.72	2.40	2.67	2.54
T_{10}	0.57	0.74	0.65	1.77	1.82	1.79	2.70	2.89	2.79
T_{11}	0.59	0.73	0.66	1.56	1.59	1.57	2.14	2.53	2.34
T_{12}	0.67	0.77	0.72	1.50	1.54	1.52	2.34	2.60	2.47
T_{13}	0.64	0.75	0.70	1.39	1.41	1.40	2.32	2.54	2.43
T_{14}	0.64	0.73	0.69	1.37	1.38	1.37	2.22	2.40	2.31
SEm±	0.02	0.01	0.01	0.06	0.07	0.05	0.09	0.11	0.08
C.D. (0.05)	0.07	NS	0.03	0.20	0.20	0.15	0.27	0.32	0.25

Number of leaves per plant

It is evident from the data that number of leaves per plant was significantly affected by various nitrogen treatments in both the years and pooled mean data over the years at both the stages of crop growth. The number of leaves per plant were recorded maximum under treatment T_6 (RDN- 75% NCU + 25% VC) during both the years and pooled analysis over the years. However, at initial growth stage (at 30 DAS) it was recorded maximum under both treatment T_6 (RDN- 75% NCU + 25% VC) and T_{11} (RDN- 100% Urea + 5 t/ha FYM). A critical analysis of the data (Table 3) indicated that the application of nitrogen through neem coated urea and vermicompost significantly increased the number of leaves per plant in okra as compared to no application, however, at some stages of growth not much difference was observed with other treatment combinations. This could be due to the fact that plants with sufficient nitrogen experiences high rates of photosynthesis and exhibits vigorous plant growth and development. Since, nutrients in the organic manure are released gradually through the process of mineralization maintaining optimal soil nutrient levels over prolonged period of time (Bationo *et al.*, 2004) [4]. Therefore, neem coated urea together with organic manure might have resulted in higher number of leaves per plant. Bharadiya *et al.* (2008) [5] also reported similar findings with the treatment of 50% RDF through inorganic and 50% RDF through organic manure. Wang *et al.* (2017) [17] in tomato and Singh *et al.* (2008) [20] in okra also reported similar findings with combined application of organic and inorganic sources.

Table 3: Effect of various organic and inorganic treatments on number of leaves

Treatments	Number of leaves/ plant								
	30 DAS			60 DAS			90 DAS		
	2016	2017	P	2016	2017	P	2016	2017	P
T_1	2.9	3.6	3.2	15.0	14.2	14.6	26.1	25.2	25.7
T_2	3.1	3.7	3.4	18.7	15.8	17.2	28.1	27.1	27.6
T_3	3.2	3.7	3.4	21.1	16.6	18.8	28.9	27.7	28.3
T_4	3.5	3.8	3.7	23.1	17.1	20.1	30.9	28.7	29.8
T_5	3.3	3.8	3.5	21.7	17.6	19.6	29.0	29.1	29.0
T_6	3.9	4.1	4.0	25.1	20.0	22.6	32.6	32.1	32.3
T_7	3.8	3.5	3.7	20.3	16.9	18.6	28.1	28.9	28.5
T_8	3.9	3.8	3.9	19.9	17.6	18.7	26.7	30.4	28.6
T_9	3.4	3.4	3.4	20.7	17.1	18.9	28.8	29.0	28.9
T_{10}	3.5	3.4	3.4	22.3	18.2	20.3	31.7	30.9	31.3
T_{11}	4.0	3.9	4.0	21.4	17.7	19.6	29.7	29.8	29.8
T_{12}	3.3	3.2	3.2	23.3	18.0	20.6	31.6	30.5	31.0
T_{13}	3.8	4.0	3.9	23.0	16.9	20.0	31.3	29.2	30.3
T_{14}	3.7	3.8	3.8	23.1	16.1	19.6	31.4	27.7	29.6
SEm±	0.1	0.1	0.1	0.9	0.7	0.5	1.2	1.1	0.8
C.D. (0.05)	0.5	0.4	0.3	2.6	2.1	1.6	3.5	3.4	2.4

Leaf area index

The leaf area index at 60 DAS was found significantly affected by the various treatments. The maximum leaf area index was recorded under treatment T_6 (RDN- 75% NCU + 25% VC) during both the years and pooled analysis over the years, while treatment T_1 (No application of nitrogen) recorded minimum leaf area index. The data (Table 4) clearly indicated that neem coated urea in combination with vermicompost increased the leaf area index of okra plants as compared to no application of nitrogen or sole application of nitrogen through inorganic fertilizer. This might be due to the nitrogen in the vermicompost which releases gradually through the process of mineralization maintaining optimal soil levels over prolonged periods of time thus, leading to increased growth parameters (Bationo *et al.*, 2004) [4].

Table 4: Effect of various organic and inorganic treatments on leaf area index and days to 50% flowering

Treatments	Leaf area index at 60 DAS			Days to 50% flowering		
	2016	**2017**	**Pooled**	**2016**	**2017**	**Pooled**
T_1	1.5	1.5	1.5	40.3	42.7	41.5
T_2	2.6	1.9	2.2	42.7	45.0	43.8
T_3	3.0	2.2	2.6	41.7	45.7	43.7
T_4	4.5	3.0	3.7	45.3	45.3	45.3
T_5	4.7	3.1	3.9	41.7	45.3	43.5
T_6	6.1	4.7	5.4	41.3	43.7	42.5
T_7	4.6	3.3	4.0	45.7	45.3	45.5
T_8	2.9	2.5	2.7	42.3	43.7	43.0
T_9	3.8	2.7	3.3	42.7	44.7	43.7
T_{10}	5.2	3.5	4.3	44.7	43.3	44.0
T_{11}	4.7	3.1	3.9	41.7	45.3	43.5
T_{12}	5.4	4.1	4.7	43.7	44.0	43.8
T_{13}	4.1	2.7	3.4	43.3	45.0	44.2
T_{14}	3.8	2.4	3.1	45.7	46.3	46.0
SEm±	0.3	0.2	0.2	0.7	0.6	0.5
C.D. (0.05)	1.0	0.6	0.6	2.3	1.8	1.5

The improvements in plant growth could also be partially due to large increases in soil microbial biomass after vermicompost applications, leading to production of hormones or humic acids in the vermicomposts acting as plant growth regulators independent of nutrient supply (Arancon *et al.*, 2003) [2]. Our results are in agreement with the findings of Vijetha (2006) [21] in okra who reported higher leaf area index with the application of vermicompost together with inorganic fertilizers. Singh *et al.* (2010) [19] in tomato and Rao *et al.* (2004) [17] in rice also reported similar results.

Days to 50% flowering

The data pertaining to days to 50% flowering was found significantly affected in both the years and pooled mean over the years. Treatment T_1 (No application of nitrogen) recorded significantly minimum days to 50% flowering in both the years and pooled mean over the years. A critical analysis of the data (Table 4) indicated that no application of nitrogen (control) recorded earliest days to 50% flowering, while application of recommended dose of nitrogen through inorganic and organic sources. This might be due to synergistic effect of nutrients (Prajapati, 2011) [14] which may have induced late flowering, whereas control treatments produced earliest flowering since not applied with nitrogen sources. Similar results were also found by Prabu *et al.* (2002) [13] and Bharadiya *et al.* (2008) [5] who also reported that days to 50% flowering decreased significantly with increase in fertilizer dose.

Yield parameter

Marketable green pod yield

The data (**Table 5**) clearly indicated that marketable green pod yield of okra was significantly affected by various treatments during both the years and pooled mean over the years. The values were in the range between 77.9 to 155.6 q/ ha. In first year, the highest marketable green pod yield (155.6 q/ ha) was recorded under treatment T_6 (RDN- 75% NCU + 25% VC), whereas, in second year it was recorded significantly highest (150.3 q/ ha) under treatment T_{10} (RDN- 100% NCU + 2.5 t/ha VC). The pooled data over the years showed that treatment T_6 (RDN- 75% NCU + 25% VC) recorded the significantly highest marketable green pod yield (151.2 q/ ha). Perusal of the data revealed that application of neem coated urea along with organic manure (especially vermicompost) recorded higher marketable green pod yield of okra as compared to all other treatments. This could be attributed to the neem oil coating and slow nutrient releasing property of neem coated urea which could have thereby reduced the nutrient losses and maintained the availability of nutrients for a longer time that resulted in better growth parameters thus increasing the marketable green pod yield. Perera and Nanthakumaran (2015) [12] also reported increase in marketable yield of green pods with application of vermicompost and inorganic fertilizer in combination (50:50) as compared to sole application of inorganic fertilizer. Higher marketable yield with the application of vermicompost were also reported by Ansari and Kumar Sukhraj (2010) [1] in okra and Arancon *et al.* (2003) [2] in tomato, capsicum and strawberry. Similar results were also reported with the use of neem coated urea by Prasad *et al.* (1999) [15] in rice crop.

Table 5: Effect of various organic and inorganic treatments on marketable green pod yield of okra

Treatments	Marketable green pod yield (q/ ha)		
	2016	**2017**	**Pooled**
T_1	81.3	77.9	79.6
T_2	104.8	92.2	98.5
T_3	107.9	100.3	104.1
T_4	139.8	110.1	124.9
T_5	115.1	124.1	119.6
T_6	155.6	146.9	151.2
T_7	108.4	108.8	108.6
T_8	135.6	139.4	137.5

T_9	115.7	111.9	113.8
T_{10}	145.3	150.3	147.8
T_{11}	113.0	113.5	113.2
T_{12}	114.5	109.8	112.2
T_{13}	112.5	116.7	114.6
T_{14}	107.2	105.9	106.5
SEm±	6.8	8.3	6.1
C.D. (0.05)	20.0	24.4	17.8

Conclusion

On the basis of present investigation, it is concluded that application of recommended doses of nitrogen through neem coated urea and vermi-compost shown an improvement in growth parameters *viz.*, plant height, stem diameter, number of leaves per plant, leaf area index and also the marketable green pod yield in comparison to control. Since, treatment T_6 (RDN- 75% NCU + 25% VC) proved to be the best for obtaining the higher marketable green pod yield therefore, it could be recommended for commercial production of okra under present agro-climatic conditions.

References

1. Ansari AA, Kumar Sukhraj K. Effect of vermiwash and vermicompost on soil parameters and productivity of okra (*Abelmoschus esculentus*) in Guyana. African Journal of Agricultural Research 2010; 5.14:1794–1798.
2. Arancon NQ, Edwards CA, Bierman P, Metzger JD, Lee S, Welch C. Effects of vermicomposts on growth and marketable fruits of field-grown tomatoes, peppers and strawberries. The 7th international symposium on earthworm ecology, Cardiff, Wales, 2002. *Pedobiologia* 2003; 47:731-735.
3. Attarde SB, Narkhede SD, Patil RP, Ingle ST. Effect of organic and inorganic fertilizers on the growth and nutrient content of *Abelmoschus esculentus* (Okra crop). International Journal of Current Research, 2012: 10.4:137-140.
4. Bationo A, Nandwa Kimetu JM, Kinyangi JM, Bado BV, Lompo F, Kimani S, *et al*. Sustainable intensification of crop-livestock system through manure management in eastern and western Africa: Lessons learned and emerging research opportunities, pp. 173-198. *In*: Sustainable crop-livestock production in West Africa. TSBF, Nairobi, Kenya. 2004.
5. Bharadiya PS, Kalalbandi BM, Shinde VN. Effect of inorganic and organic fertilizers on growth and yield of okra. Asian Journal of Horticulture, 2008; 3.1:112-113.
6. Das AK, Prasad B, Singh R. Response of chemical fertilizer and vermicompost on Okra (*Abelmoschus esculentus*) *cv*. Parbhani Kranti. The Asian Journal of Horticulture, 2014; 9.2:372-376.
7. Goswami NN. Soil testing as a unique test for integrated and balanced fertilizer use for optimizing production-issues, options and limitations. A key note address in the National Seminar on Soil Testing for Balanced and Integrated Use of Fertilizers delivered at IARI, New Delhi, 2006, 1-15.
8. Jaja ET, Ibeawuch II. Effect of organic and inorganic manure mixture rates on the productivity of okra. International Journal of Agriculture and Rural Development, 2015; 18.1:2085-2091.
9. Kumar D, Devakumar C, Kumar R, Das A, Panneerselvam P, Shivay YS. Effect of neem oil coated prilled urea with varying thickness of neem oil coating and nitrogen rates on productivity and nitrogen use efficiency of lowland irrigated rice under Indo-Gangetic plains. Journal of Plant Nutrition, 2010; 33.13:1939-1959.
10. Ogundare SK, Owa FD, Etukudo OO, Ibitoye-Ayeni NK. Influence of different nitrogen sources on the growth and yield of three varieties of okra (*Abelmoschus esculentus*) in Kabba, Kogi State, Nigeria. Agricultural Sciences, 2015; 6:1141-1147.
11. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi, India., 1967.
12. Perera KIM, Nanthakumaran A. Technical feasibility and effectiveness of vermicomposting at household level. Tropical Plant Research, 2015; 2.1:51-57.
13. Prabu T, Ismail S, Sajindranath AK, Savithiri R. Effect of integrated nutrient management on yield, dry matter and nutrient content in okra. Orissa Journal of Horticulture 2002; 30.2:52-56.
14. Prajapati JL. Effect of NPK, vermiwash and vermicompost on the growth and yield of okra [*Abelmoschus esculentus* (L.) Moench]. *M.Sc. thesis* submitted to JNKVV, Jabalpur, 2011, 115p.
15. Prasad R, Singh S, Saxena VS, Devkumar C. Coating of prilled urea with neem (*Azadirachta indica* juss) oil for efficient nitrogen use in rice. *Naturwissenschaften,* 1999; 86.11:538-539.
16. Ramamoorthy B, Narasimham RL, Dinesh RS. Fertilizer application for specific yield targets on Sonora 64 (wheat). Indian Farming, 1967; 17.5:43-45.
17. Rao AS, Reddy KS. Analysis of soils for pH, EC and available major nutrients. *In*: Tandon, H.L.S. (Ed.) Methods of analysis of soils, plants, waters, fertilizers and organic manures. Fertiliser Development and Consultation Organisation, New Delhi, India, 2009, 21-25.
18. Rawat S, Singh S, Gangola P, Gautam P. Studies on soil test crop response correlation for optimizing fertilizer recommendation to okra grown on Mollisol of Uttarakhand. International Journal of Basic and Applied Agricultural Research, 2015; 13.2:254-257.
19. Singh BK, Pathak KA, Boopathi T, Deka BC. Vermicompost and NPK fertilizer effects on morpho-physiological traits of plants, yield and quality of tomato fruits (*Solanum lycopersicum* L.). Vegetable Crops Research Bulletin, 2010; 73:77-86.
20. Singh SK, Chaurasia SNS, Singh TB, Mishra TD. Effect of nutrient dynamics on growth and yield of okra (Abelmoschus esculentus Moench) cv. VRO-6. *Agriculturist* 2008; 19.2:19-23.
21. Vijetha P. Effect of organic and inorganic nutreints on the yield and quality of okra. *M.Sc. thesis* submitted to ANGRAU, Hyderabad, 2006, 119p.
22. Wang XX, Zhao F, Zhang G, Zhang Y, Yang L. Vermicompost improves tomato yield and quality and the biochemical properties of soils with different tomato planting history in a greenhouse study. Frontiers in Plant Science, 2017; 8:1-11.