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Effect of Different Organic Manures and their Combinations on Growth, Yield and Quality of Bitter Gourd cv Pusa Do Mausami under Sub Tropical Condition of Garhwal Hills

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ABSTRACT

Present research work on the effect of different organic manures and their combinations on growth, yield, and quality of bitter gourd cv Pusa Do Mausami were carried out at the Horticultural Research Center, Department of Horticulture, HNB Garhwal University, Uttarakhand during the summer season of 2017. The experiment was comprised of 11 treatments consisting of different organic manures and their combinations which were laid out in Randomized Block Design with three replications. The result of the analysis of variance revealed that the mean sum of squares due to treatment was significant at a 5% level for almost all the traits. The result showed that T_9 (vermicompost + poultry manure) responded best for days taken to the appearance of the first male flower (55.53) and female flower (61.53), number of fruits/vine (28.06), weight of fruit (71.67g), days taken to first fruit harvest (80.53 days) and harvesting duration (60.40 days). The treatment T_4 (neem cake) showed best for diameter of fruit (44.4 mm), fruit yield/vine (1793.06 g), yield/plot (16.13 kg/plot) and yield/hectare (179.25 q/ha), respectively. On the other hand, the highest TSS (5.28 ^{o}Brix) and ascorbic acid (89.99 mg/100 g) content was estimated in T_3 (goat manure). Thus, it can be concluded that the treatment T_4 (neem cake) and T_3 (goat manure) showed superior results with respect to yield and quality traits of bitter gourd respectively. Hence, these treatments could be used to enhance the production of bitter gourd under subtropical condition of Garhwal hills.

Keywords Bitter gourd, Goat manure, Neem cake, Organic manures, Poultry manure, Vermicompost.

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INTRODUCTION

Bitter gourd (*Momordica charantia* L.) 2n=2x=22 is an important commercial cucurbit belonging to the genus *Momordica* and family cucurbitaceae. It is considered as one of the important warm-season cucurbitaceous vegetable crop of this family. Bitter gourd is known by different names viz., balsam pear, bitter melon, and karela (Jia *et al.* 2017). The crop is widely grown in Africa, China, India, Malaysia

and South America (Prasanth *et al*. 2020). In India, it is mainly grown in Karnataka, Maharashtra, Tamil Nadu, Kerala, and Andhra Pradesh occupying an area of 101 thousand hectares with a production of 1214 MT and productivity of 12.01 tonnes per hectare (National Horticulture Board 2019-20). Bitter gourd has several uses like the fruits are used as a vegetable in many ways and are quite commonly consumed as fried, cooked, stuffed and also in the form of curries and pickles. The crop is also known for possessing several medicinal properties for preventing and curing several human illnesses such as cancer, diabetes mellitus (Giovannini *et al.* 2016), inflammation (Saeed *et al.* 2018), toothache, jaundice, leprosy, pneumonia, rheumatism (Jia *et al.* 2017) and many more.

The green revolution has promoted the utilization of synthetic fertilizers to accomplish higher profitability and yield (Nelson *et al.* 2019), however because of the ceaseless and aimless utilization of fertilizers, the characteristic fruitfulness of soil has been decreased and this movement has tainted our soil, water and sustenance. However, it is also a fact that the burgeoning population across the globe has raised the demand for food including vegetables and as such the concern related to issues such as human health, maintenance of ecological balance, and conservation of biodiversity cannot be overlooked. Fulfilment of such food demand without affecting the soil health and environment, switching over to a system that is sustainable and environmentally friendly i.e., a system which is particularly driven by inputs of organic nature originated mainly from plant and animal base is a need of an hour. Thus, in view of the above facts, a field experiment was conducted to study the effect of different organic manures and their combinations on the growth, yield and quality of bitter gourd and to find out the best organic manures or their combinations for bitter gourd under subtropical condition of Garhwal hills.

MATERIALS AND METHODS

The present study was carried out at the Horticultural Research Center, Department of Horticulture, HNB Garhwal University (A Central University), Srinagar, Garhwal, Uttarakhand, India during the summer season 2017. Geographically, the Horticultural Research Center is situated in the valley of Alakananda river which lies between 78°47'30" E longitude and 30°13'0"N latitude, right in the heart of Garhwal region at an elevation of 540 m above MSL, in the lesser Himalayan region. The climate of the Horticultural Research Center is humid sub-tropical with minimum and maximum temperatures ranging between 7.5°C to 25.8°C and 17.7°C to 40°C, respectively during the experimentation. The soil of the experimental site was sandy loam with a pH of 6.3, organic carbon 0.84%, available nitrogen 96.6 kg/ha, available phosphorus 3.05 kg/ha and available potassium 136 kg/ha. The experiment was comprised of 11 treatments consisting of different organic manures and their combinations viz., T_1 (farmyard manure @ 25 t ha^{-1}), T_2 (poultry manure @8t ha^{-1}), T_3 (goat manure @10t ha^{-1}), T_4 (neem cake @ 5 t ha^{-1}), T_5 (vermicompost @10 t ha^{-1}), T_6 (farmyard manure @ 25 t ha^{-1} + poultry manure @ 8 t ha^{-1}), T_7 (poultry manure @ 8 t ha^{-1} + goat manure @10 t ha^{-1}), T_8 (goat manure @10 t ha^{-1} + neem cake @ 5 t ha^{-1}), T_9 (vermicompost @10 t ha^{-1} + poultry manure @ 8 t ha^{-1}), T_{10} (neem cake @ 5 t ha^{-1} + farmyard manure @25 t ha^{-1}) and T_{11} (control). The experimental plots were laid out in Randomized Block Design with three replications. Bitter gourd cultivar Pusa Do Mausami was used as a variety for the experiment which was collected from IARI, New Delhi. The seed of bitter gourd was sown in each polybag in the month of March 2017. Then a recommended dose of different organic manures and their combinations were applied 15 days before transplanting of seedlings as per the experimental plan. The uniform and healthy seedlings of four to six leaf stages were transplanted in the experimental field. During the experiment, five plants were randomly selected from each treatment per replication for recording observations in respect of growth, yield and quality parameters. The quality analysis i.e. total soluble solid was determined with the help of a hand refractometer (0-32%) and the ascorbic acid content in fruits was estimated as per the procedure given by Ranganna (2004). The observations recorded for various characters were used for statistical analysis and data were analyzed according to the procedure of analysis of variance for Randomized Block Design with three replications (Snedecor and Cochran 1961). The significance of variation among the treatments was observed by applying analysis of variance

Table 1. Effect on various growth parameters of bitter gourd cv Pusa Do Mausami as influenced by various treatments. T_1 (farmyard manure @ 25 t ha^{-1}), T_2 (poultry manure @ 8 t ha^{-1}), T_3 (goat manure @10 t ha^{-1}), T_4 (neem cake @ 5 t ha^{-1}), T_5 (vermicompost @10 t ha^{-1}), T_6 (farmyard manure @ 25 t ha^{-1}+ poultry manure @ 8 t ha^{-1}), T_7 (poultry manure @ 8 t ha^{-1} + goat manure @10 t ha^{-1}), T_8 (goat manure @10 t ha^{-1} + neem cake @ 5 t ha^{-1}), T_9 (vermicompost @10 t ha^{-1} + poultry manure @ 8 t ha^{-1}), T_{10} (neem cake @ 5 t ha^{-1} + farmyard manure @ 25 t ha^{-1}) and T_{11} (control).

Treatments	Length of vine (cm)	No. of primary branches/vine	Days taken to appearance of 1st male flower	No. of nodes bearing 1st male flower	Days taken to appearance of 1st female flower	No. of nodes bearing 1st female flower
T_1	444.60	23.66	62.47	6.33	68.47	17.55
T_2	483.41	20.88	58.13	6.22	64.47	20.84
T_3	449.37	20.11	66.20	6.55	71.87	21.25
T_4	439.52	24.77	65.27	7.10	70.60	19.99
T_5	413.41	20.55	59.33	6.88	64.99	14.77
T_6	450.89	18.77	58.33	7.22	64.67	14.88
T_7	453.54	22.66	62.07	5.47	68.07	23.74
T_8	453.74	18.21	62.67	7.88	68.33	20.25
T_9	344.93	21.32	55.53	7.44	61.53	22.33
T_{10}	486.25	21.99	64.33	7.32	69.93	21.25
T_{11}	309.06	16.10	62.22	7.88	67.93	14.95
SEm (±)	23.75	1.28	3.10	0.56	3.00	1.19
CD 5%	70.05	3.77	9.15	1.64	8.85	3.51

(ANOVA) and Critical Difference (CD) test at a 5% probability level.

RESULTS AND DISCUSSION

Effect on growth

The effect of different organic manures on the various growth parameters has been elicited in Table 1. Henceforth regarding the vine length of bitter gourd, it is evident that the maximal length of the vine (486.25 cm) was recorded in the combination of neem cake + farmyard manure (T_{10}), which was found significantly superior over the rest of the treatments. The combined application of neem cake and farmyard manure rich in organic carbon might have bolstered the quality of soil (humus content, physical properties, organic matter, and water-holding capacity) improving the nutrients availability for plants, ultimately resulting in the increase in vine length. Also, the combination of organic sources like neem cake and farmyard manure resulted in a steady nutrient supply favoring the conversion of carbohydrates into protein and its elaboration into protoplasm. This can be a reasonable explanation as the minimum (309.06 cm) vine length was recorded in control (T_{11}). Getting on to the effect of organic manures on primary branches, at harvest the maximum number (24.77) was noted in the plants treated with only neem cake (T_4) followed by plants treated with farmyard manure (T_1) while the minimum (16.1) number of primary branches per vine was recorded in treatment T_{11} (control). Similar findings have been reported by Veena *et al.* (2017) in chilli.

Flowering in plants is generally determined by genetic factors as well as various environmental factors viz., stresses, temperature, day length (Cho *et al.* 2017). Regarding the effect of treatments on flowering, the minimum number of days (55.53 days) taken for the appearance of a first male flower was recorded in the treatment consisting of vermicompost + poultry manure (T_9) against the treatment of goat manure (T_3) wherein the first male flowers came into view at 66.20 days after sowing. Similarly, minimum days (61.53 days) taken to the appearance of the first female flowers were seen to be at the earliest in plot receiving vermicompost + poultry manure (T_9) followed by 64.47 days in T_2 (poultry manure) whilst, it was extended to 71.87 days (maximum) in plot receiving only goat manure (T_3). The minimum days taken to the appearance of the male flower might be due to various hormonal activities induced by several bacteria and fungi present in vermicompost and also due to the presence of higher macro and mi-

Table 2. Effect on yield and yield contributing characters of bitter gourd cv Pusa Do Mausami as influenced by various treatments. T_1 (farmyard manure @ 25 t ha^{-1}), T_2 (poultry manure @ 8t ha^{-1}), T_3 (goat manure @10 t ha^{-1}), T_4 (neem cake @ 5 t ha^{-1}), T_5 (vermicompost @ 10 t ha^{-1}), T_6 (farmyard manure @ 25 t ha^{-1}+ poultry manure @ 8 t ha^{-1}), T_7 (poultry manure @ 8t ha^{-1} + goat manure @10 t ha^{-1}), T_8 (goat manure @10 t ha^{-1} + neem cake @ 5 t ha^{-1}), T_9 (vermicompost @10 t ha^{-1} + poultry manure @ 8 t ha^{-1}), T_{10} (neem cake @ 5 t ha^{-1} + farmyard manure @ 25 t ha^{-1}) and T_{11} (control).

Treatments	Sex ratio	Days taken to first fruit harvest	Harvesting duration (days)	Number of fruits per vine	Average fruit weight (g)	Length of fruit (cm)	Diameter of fruit (mm)	Fruit yield per vine (g)	Fruit yield per plot (kg)	Fruit yield per hectare (q)
T_1	14.60	88.13	55.13	22.60	68.58	13.95	38.53	1440.00	13.16	167.66
T_2	15.12	83.13	59.73	27.46	64.35	15.13	42.50	1771.86	16.45	209.58
T_3	14.72	91.53	52.27	19.93	65.21	14.47	39.04	1300.66	10.72	136.58
T_4	15.27	88.93	54.27	22.86	66.25	15.02	44.40	1793.06	17.13	218.24
T_5	15.82	83.66	49.00	17.30	59.31	14.42	39.29	905.40	8.75	111.48
T_6	10.77	84.00	57.60	27.00	65.10	14.73	42.79	1766.26	15.90	202.57
T_7	13.65	88.06	55.13	24.60	66.59	14.29	41.11	1528.26	13.89	176.96
T_8	14.51	87.33	55.47	23.93	69.28	14.13	42.33	1510.66	12.96	165.12
T_9	13.97	80.53	60.40	28.06	71.67	15.80	43.40	1638.00	14.96	190.60
T_{10}	10.77	88.26	53.60	24.73	71.64	16.06	42.09	1728.93	14.28	181.93
T_{11}	13.95	87.26	56.13	14.93	57.26	11.49	37.79	826.00	8.15	103.83
SEm (±)	0.70	3.30	3.04	2.10	2.51	0.57	1.40	149.67	1.24	13.58
CD 5%	2.06	9.74	8.97	6.19	7.41	1.69	4.12	441.53	3.65	40.06

cronutrients in the enriched poultry manure resulting in the rapid enhancement in the growth of the plant ultimately promoting earliness in flowering. Rekha *et al.* (2018) also highlighted that vermicompost has been scientifically proven as a miracle plant growth enhancer. On the other hand, the differences in days taken to the appearance of female flowers may be due to genetic nature, environmental factors, and the vigor of the crop influenced by different organic sources. The combined application of treatments also might have resulted in synthesis of flowering hormones leading to appearance of a female flower in earlier days. Earliness in the appearance of male and female flower due to the balanced supplement of nutrients through applied organic manures has also been reported by Barik *et al*. (2018).

The result regarding the number of nodes bearing the first male flower and first female flower are displayed in Table 1. The lowest number of nodes at which the first male flower and first female flower appeared (5.47 and 14.77 respectively) was noticed in the plot treated with poultry manure + goat manure (T_7) and Vermicompost (T_5) respectively. In contrast, the highest (7.88 and 23.74 respectively) number of nodes at which the first male and female flower appeared were recorded in treatment T_8 (goat manure @10 t ha^{-1} + neem cake @ 5 t ha^{-1}), T_{11} (control), and T_7 and (poultry manure + goat manure) respectively. The data regarding the number of nodes at which the first female flower appeared is found to be significant between the treatments. The appearance of female flowers at the lowest nodes is governed by the genetic architecture of the crop, soil fertility level, and environmental factors. Researchers have revealed that male flower appears at lower nodes than female flowers (Resmi and Sreelathakumary 2012, Dalamu *et al.* 2012).

Effect on yield

Organic sources of nutrients are reported to influence various yield-contributing characters (Ingole *et al.* 2018) as illustrated in Table 2. The lowest male to female ratio (10.77) was recorded in treatment T_6 (farmyard manure + poultry manure) which was found to be statically at par with T_{10} (neem cake + farmyard manure) whereas the highest male to female ratio (15.82) was noticed in T_5 (vermicompost). Sex ratio is found to be highly affected by the genetic be-

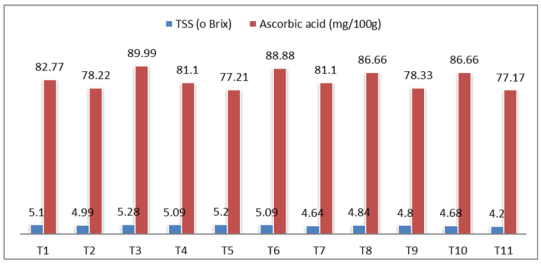

Fig. 1. Effect on quality parameters of bitter gourd cv Pusa Do Mausami as influenced by various treatments. T_1 (farmyard manure @ 25 t ha^{-1}), T_2 (poultry manure @ 8 t ha^{-1}), T_3 (goat manure @10 t ha^{-1}), T_4 (neem cake @ 5 t ha^{-1}), T_5 (vermicompost @ 10 t ha^{-1}), T_6 (farmyard manure @ 25 t ha^{-1}+ poultry manure @ 8 t ha^{-1}), T_7 (poultry manure @ 8t ha^{-1} + goat manure @10 t ha $^{-1}$), T_8 (goat manure @10 t ha^{-1} + neem cake @ 5 t ha^{-1}), T_9 (vermicompost @10 t ha^{-1} + poultry manure @ 8 t ha^{-1}), T_{10} (neem cake @ 5 t ha^{-1} + farmyard manure @ 25 t ha^{-1}) and T_{11} (control).

haviour of crops, environmental factors and available soil conditions (Singh *et al* 2016). The days taken to first fruit harvesting and the harvesting duration of bitter gourd were found to be non-significant between the treatments where T_9 (vermicompost + poultry manure) treatment attained earliest harvesting at 80.53 days with a maximum duration of harvesting up to 60.40 days. In contrast, the number of fruits per vine, average fruit weight, length of fruit, a diameter of fruit, fruit yield per vine, per plot and per hectare significantly varied among the various treatments. The number of fruits per vine ranges from 14.93 (in T_{11}) - 28.06 (in T_9) meanwhile, the average fruit weight ranges from 57.26 g (in T_{11}) - 71.67 g (in T_9). In both respects, T_9 (vermicompost + poultry manure) was found to be significantly superior over the rest of the treatments whereas T_{11} (control) showed feeble influence over these characteristics. Variation in the number of fruits per vine in bitter gourd was also reported by (Anuja and Archana 2012). The length of fruits was 16.06 cm (maximum) in plots receiving T_{10} (neem cake + farmyard manure) and could be seen lessening to 11.49 cm (minimum) in the plots without treatment T_{11} (control). This is consistent with the findings of Eifediyi *et al.* (2015) in okra. The diameter of fruit is the important trait that influences the total yield of the crop, the maximum diameter of 44.4 mm was recorded in treatment T_4 (neem cake) followed by 43.4 mm in T_9 (vermicompost + poultry manure) and 42.79 mm in T_6 (farmyard manure + poultry manure). On the other hand, the minimum (37.79 mm) diameter of fruit was found in treatment T_{11} (control). Similar outcomes have been revealed by Eifediyi *et al.* (2015) in okra, plausibly due to the slow release of nutrients by the neem cake which maintains the nutrient availability to plants for longer periods. Expectedly, a similar result concerning yield has been reported in this experiment i.e., the maximum yield per vine (1793.06 g), yield per plot (17.13 kg/plot) and yield per hectare (218.24 q/ha) was recorded in treatment T_4 (neem cake). In contrast, the minimum fruit yield per vine, fruit yield per plot and fruit yield per hectare was observed in T_{11} (control). Besides improving the structure, productivity, nutrient status and microbial activities the applied neem cake also might have reduced the insect-pest and diseases attack due to its biocidal potency which else might have affected the yield attributes of the plants. The bioactive compound present in neem possess biocidal potency beneficial in controlling several crop pests and diseases have also been reported by Adusei and Azupio (2022). Moreover, the addition of neem cake also improved the availability of nutrients and causes more uptakes by the plants favouring the highest number of leaves and more photosynthesis and enhanced food accumulation which is reflected in the highest fruit yield per vine, fruit yield per plot, and yield per hectare. Similar findings in the case of fruit yield per vine/plant, yield per plot, and yield per hectare have been reported by Eifediyi *et al.* (2015) in okra and Veena *et al.* (2017) in chilli.

Effect on quality

The quality parameters viz. total soluble solids and ascorbic acid content of bitter gourd cv Pusa Do Mausami was influenced by organic manures in the same manner as that of growth and yield parameters which are depicted in Fig. 1. In both the analyzed quality parameters goat manure (T_3) reported to be superior over the rest of the treatments. The result after the analysis revealed that the maximum (5.28 ^{o}Brix) total soluble solids in fruits were reported in T_3 (goat manure) whereas the minimum was recorded in T_{11} (control). This could be due to the influence of nutrient levels applied through goat manure which might have affected the proportion of total soluble solids in the fruits. In addition, it also might be due to the accumulation of more reserve substances in

fruit. Similarly, the maximum ascorbic acid content (89.99 mg/100 g) in the fruits was reported in the same treatment i.e., T_3 (goat manure) however, the minimum (77.17 mg/100g) value concerning the ascorbic acid content was recorded in T_{11} (control). This may be due to environmental factors (light, temperature, water), the genetic factor of the plant, and may also be due to an increase in fertility of the soil by the application of the treatment which might have secreted some growth promoting substances and also may have accelerated the physiological processes like synthesis of carbohydrates leading to increase in the ascorbic acid content in fruits. Premamali *et al.* (2019) also reported that ascorbic acid production in fruits depends on nutrient and water content in the soil. Similarly, Belbase and Bc (2020) also revealed that the ascorbic acid content in fruits and vegetables can be influenced by the type of fertilizer used for its cultivation.

CONCLUSION

From all the above findings, it may be concluded that treatment T_4 (neem cake @ 5 t ha^{-1}) and T_3 (goat manure @10 t ha^{-1}) showed superior results with respect to yield and quality traits of bitter gourd respectively. Hence, these treatments could be used to enhance the quality production of bitter gourd under the subtropical condition of Garhwal hills.

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REFERENCES

Adusei S, Azupio S (2022) Neem : A novel biocide for pest and disease control of plants. *J Chem Article* ID 6778554 : 1—12.

Anuja S, Archana S (2012) Effect of organic nutrients on yield and quality of bitter gourd. *Int J Agric Sci* 8 (1) : 205—208.

Barik N, Phookan DB, Kumar V, Millik TT, Nath DJ (2018) Organic cultivation of ridge gourd (*Luffa acutangula* Roxb.). *Curr Appl Sci Technol* 26 (4) : 1—6.

Belbase P, Bc L (2020) Effects of different fertilizers on yield and vitamin C content of cauliflower (*Brassica oleracea* var. *botrytis*) -A review. *Asian J Agric Hortic Res* 6 (4) : 37—46.

Cho LH, Yoon J, An G (2017) The control of flowering time by environmental factors. *Pl J* 90 : 708—719.

Dalamu BT, Gaikwad A, Saxena S, Bharadwaj C, Munshi A (2012) Morphological and molecular analyses define the genetic diversity of Asian bitter gourd (*Momordica charantia* L.). *Aust J Crop Sci* 6 : 261—267.

Eifediyi EK, Mohammed KO, Remison SU (2015) Effects of neem (*Azadirachta indica* L.) seed cake on the growth and yield of okra (*Abelmoschus esculentus* (L.) Moench). *Poljo Privreda* 21 (1) : 46—52.

Giovannini P, Howes MJ, Edwards E (2016) Medicinal plants used in the traditional management of diabetes and its sequelae in Central America: A review. *J Ethnopharmacol* 184 : 58—71.

Ingole VS, Wagh AP, Nagre PK, Bharad SG (2018) Effect of biofertilizer and organic manure on yield and yield contributing characters of beetroot (*Beta vulgaris* L.). *Int J Chem Stud* 6(5): 1226—1228.

Jia S, Shen M, Zhang F, Xie J (2017) Recent advances in *Momordica charantia* : Functional components and biological activities. *Int J Mol Sci* 18 : 2555.

National Horticulture Board, Data Base (2019-20) 2nd advance estimates.

Nelson ARLE, Ravichandran K, Antony U (2019) The impact of the green revolution on indigenous crops of India. *J Ethn Foods* 6 (8) : 1—10.

Prasanth K, Sadashiva AT, Pitchaimuthu M, Varalakshmi B (2020) Genetic diversity, variability and correlation studies in bitter gourd (*Momordica charantia* L.). *Ind J Pl Genet Resour* 33 (2) : 102—105.

Premamali M, Kannangara KN, Yapa PI (2019) Impact of composting on growth, vitamin C and calcium content of *Capsicum chinense. Sustain Agric Res* 8 (3) : 57—65.

Ranganna S (2004) Handbook of analysis and quality control for fruit and vegetable production (2nd ed). Mc-Graw Hill Education (India) Private Limited New Delhi, pp 105—126.

Rekha GS, Kaleena PK, Elumalai D, Srikumaran MP, Maheswari VN (2018) Effects of vermicompost and plant growth enhancers on the exo morphological features of *Capsicum annum* (Linn.) Hepper. *Int J Recycl* 7 : 83—88.

Resmi J, Sreelathakumary I (2012) Studies on genetic divergence in bitter gourd (*Momordica charantia* L.). *J Hortic Sci* 7 : 152—155.

Saeed F, Afzaal M, Niaz B, Arshad MU, Tufail T, Hussain MB, Javed A (2018) Bitter melon (*Momordica charantia*): A natural healthy vegetable. *Int J Food Prop* 21(1) : 1270—1290.

Singh V, Shah KN, Rana DK (2016) Performance of different bitter gourd (*Momordica charantia* L.) strain for growth, yield and quality traits under Garhwal hills. *Pl Arch* 16 (2) : 815—820.

Snedecor GW, Cochran WG (1961) Statistical methods. Iowa State University Press, Ames, USA.

Veena SK, Giraddi RS, Bhemmanna M, Kandpal K (2017) Effect of neem cake and vermicompost on growth and yield parameter of chilli. *J Entomol Zool Stud* 5 (5) : 1042—1044.