International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2017; 5(3): 225-229

Received: 04-03-2017
Accepted: 05-04-2017

M Raviprasad Sajjan
Department of Horticulture, College of Agriculture University of Agricultural Sciences, Dharwad, Karnataka, India

CK Venugopal
Department of Horticulture, College of Agriculture University of Agricultural Sciences, Dharwad, Karnataka, India

Correspondence
M Raviprasad Sajjan
Department of Horticulture, College of Agriculture University of Agricultural Sciences, Dharwad, Karnataka, India

Studies on the effect of planting methods and nutrition on growth, yield and essential oil content in vetiver (*Vetiveria zizanioides* (L.) Nash)

M Raviprasad Sajjan and CK Venugopal

Abstract
A field experiment was conducted at Medicinal and Aromatic Plants Unit, Saidapur Farm, Department of Horticulture, College of Agriculture, University of Agricultural Sciences, Dharwad, Karnataka to study the effect of planting methods and nutrition on growth, yield and essential oil content in vetiver (*Vetiveria zizanioides* (L.) Nash Syn. *Chrysopogan zizanioides*) during July 2015- July 2016. The experiment was laid out in split plot design with three main plot and six sub plot comprising of eighteen treatment combinations with two replications. The main plot consisted of three planting methods; P_1– Ridge and furrow method, P_2– Bed method and P_3– Bag method. The sub plot consisted of six fertilizer levels; F_1- 25:25:25 kg NPK/ha, F_2- 50:25:25 kg NPK/ha, F_3- 75:25:25 kg NPK/ha, F_4- 25:50:25 kg NPK/ha, F_5- 50:50:25 kg NPK/ha and F_6- 75:50:25 kg NPK/ha. For all the treatments, farm yard manure @ 10 tonnes per ha was applied. Among the planting methods, bag method (P_3) recorded significantly higher plant height (181.6 cm), number of tillers per plant (110.3), number of leaves per plant (737.1), number of roots per plant (317.0), dry root weight (95.1 g/plant), dry root yield (4085.8 kg/ha) and essential oil yield (85.3 kg/ha) compared to other planting methods. Among fertilizer levels, 75:50:25 kg NPK/ha (F_6) recorded significantly higher plant height (180.1 cm), number of tillers per plant (111.2), number of leaves per plant (739.2), number of roots per plant (261.0), dry root weight (86.3 g/plant), dry root yield (3686.5 kg/ha) and essential oil yield (78.4 kg/ha) compared to other fertilizer levels.

Keywords: Essential oil, nutrition, planting methods, root yield, vetiver

1. Introduction
Vetiver (*Vetiveria zizanioides* (L.) Nash Syn. *Chrysopogan zizanioides*) is a densely tufted, perennial, important aromatic plant belongs to the family Poaceae. Vetiver is having several vernacular names in India such as Usirah, Sugandhimulah in Sanskrit, Lavancha in Kannada, Vettiver in Tamil, Khus-khus in Hindi and Bengali, whereas, it is more commonly known as Vetiver in English (Archana Pareek and Ashwani Kumar, 2013) [1]. Vetiver is indigenous to India and widely cultivated in the tropical and sub-tropical regions of the world. In India, khus grass grows wild in Rajasthan, Haryana, Uttar Pradesh, Gujarat, Bihar, Orissa, Madhya Pradesh and throughout South India. It is systematically cultivated in the North Indian states of Rajasthan, Uttar Pradesh and in the South Indian states of Kerala, Tamil Nadu, Karnataka and Andhra Pradesh.

The roots of vetiver on steam distillation yield an aromatic high grade natural essential oil which is mainly used as a fixative in perfumery and cosmetic industries and for the scenting soaps and extensively used in tobacco, pan masala and beverage industries. The oil has antifungal, antibacterial, anticancer, anti-inflammatory and antioxidant activities, thus having application in the pharmaceutical industries (Prakasa Rao *et al*., 2011) [8]. Root is cooling, bitter, alexiteric, stomachic, carminative, astringent, stimulates immune system, menstruation, useful in headache, burning sensations, ulcers, rheumatism and diseases of blood.

The present annual world production of vetiver oil is approximately 250-300 tonnes, while the demand is nearly 400 tonnes. Haiti and Indonesia account for 80 per cent of total vetiver oil production in the world. In India, about 20-25 tonnes of oil is produced annually, which is far below the Indian demand level (100 tonnes) which is met by imports. The heavy demand of vetiver oil in Indian as well as international markets has motivated Indian farmers to take up commercial cultivation of vetiver.

The cultural practices including planting methods and nutrition management are the important factors that play a vital role in growth and productivity of vetiver.

Despite its economic importance, growers are not in a position to produce good quality vetiver with high productivity due to difficulty in harvesting of roots, as the roots grow deep into soil, sometimes upto 2-3 feet. Boonklinkajorn and Visuttipitakul (2001) [2] observed that there was a great loss of root caused by harvesting procedure. Since the grass extends its fibrous roots in all directions, a certain portion of the roots was unavoidably cut off. The amount of roots left in the soil is believed to be considerable. Conventionally khus roots are harvested manually using traditional tools like spade, pickaxe and narrow spade etc., which causes significant damage and root losses (approx. 30-40%). Alternatively, a plough would be run to loosen the soil along the rows of plant to facilitate easy pulling out of clumps of vetiver. Besides, this method requires huge involvement of drudgeryful manual labour (345-350 man days/ha) (Tiwari, 2014) [11]. To overcome these problems and making the vetiver cultivation sustainable and profitable, there was a need to find out suitable planting methods so that harvesting of roots become easy.

Plant nutrition is also a major factor which influences the growth and development of crops that are grown commercially, under normal agro-climatic conditions. The deficiency of major nutrients namely nitrogen, phosphorus and potassium are common and they pose serious problems in commercial crop production. Inadequate supply of these nutrients even for a short period is detrimental to plant and has a negative effect on yield. Use of organic manures alone cannot fulfil the nutrients requirement. Therefore, it is imperative to make use of organic manures along with inorganic fertilizers to maintain soil fertility and to get sustainable yields (Harshavardhan *et al*., 2016) [4].

Comparatively very meagre research has been carried out in our country on this crop on these aspects. Keeping these points in view, the present study was conducted to study the effect of planting methods and nutrition on growth, yield and essential oil content in vetiver.

Materials and Methods

A field investigation was conducted at Medicinal and Aromatic Plants Unit, Saidapur Farm, Department of Horticulture, College of Agriculture, University of Agricultural Sciences, Dharwad, Karnataka to study the effect of planting methods and nutrition on growth, yield and essential oil content in vetiver during July 2015 to July 2016. The soil of experimental plot was clay loam with soil pH 7.36, organic carbon content of 0.57%, available nitrogen of 147 kg/ha, available phosphorus of 39.30 kg/ha and available potassium 144 kg/ha. The experiment was laid out in split plot design with three main plot and six sub plot comprising of eighteen treatment combinations with two replications. The main plot consisted of three planting methods viz., P_1– Ridge and furrow method, P_2– Bed method and P_3– Bag method. The sub plot consisted of six fertilizer levels; F_1- 25:25:25 kg NPK/ha, F_2- 50:25:25 kg NPK/ha, F_3- 75:25:25 kg NPK/ha, F_4- 25:50:25 kg NPK/ha, F_5- 50:50:25 kg NPK/ha and F_6- 75:50:25 kg NPK/ha. For all the treatments, farm yard manure at the rate of 10 tonnes per ha was applied. The gross plot size of each treatment was 2.7m x 2.4m and net plot size was 1.8m x 1.8m, respectively. The individual plots were levelled and the layout was made as per the plan.

For planting purpose, healthy planting materials were obtained from the nursery of CSIR-Central Institute of Medicinal and Aromatic Plants (CIMAP) Research Centre, Bengaluru. The healthy clumps were uprooted and individual tillers or root slips were separated from the mother plant. Shoots were cut at 25 cm height above the ground level, roots were trimmed and dry foliage removed before they were used for planting. During planting, ridges of 15 cm height were made at 45 cm apart in case of ridge and furrow method; and raised beds of 15 cm height (two rows/bed) of required size were prepared in case of bed method. The empty cement bags (50 kg capacity) were washed and filled (upto 3/4th height) with soil and FYM mixture in case of bag method. In case of ridge and furrow method, the slips were planted singly on one side of the ridge at 30 cm spacing between each slip. In case of bed method, the slips were planted singly in rows of 45 cm apart at 30 cm spacing between each slip. In case of bag method, root slips were planted singly in each bag and bags were kept at requisite spacing. The root slips were planted on 31-7-2015 and harvesting of roots were done at 12 months after planting.

The farm yard manure @ 10 tonnes per ha was applied to all the treatments one month before planting. Nitrogen, phosphorus and potassium were applied in the form of urea (46% N), single super phosphate (16% P_2O_5) and muriate of potash (60% K_2O), respectively as per the treatments. At the time of planting, half dose of N and full dose of P and K were applied as a basal dose. Remaining half of nitrogen was applied after four months of planting. The experimental field was regularly irrigated and weeded.

Five representative plants in each treatment and in each replication were randomly selected, tagged and bio-metric observations on growth characters viz., plant height, number of tillers per plant, number of leaves per plant and yield attributing parameters viz., number of roots and dry root weight from five plants were collected at harvest and their mean values were recorded. After harvesting of the crop, the dry root yield per plot and dry root yield per hectare were recorded. The essential oil content in roots (%) was estimated by using Clevenger's apparatus and essential oil yield per hectare was worked out. The data were subjected to statistical analysis as suggested by Gomez and Gomez (1984) [3].

Results and Discussion

The perusal of data clearly indicated that the planting methods and fertilizer levels individually and in their interaction significantly influenced the growth, yield and yield attributing parameters and essential oil yield in vetiver (Table 1 and 2).

Among the planting methods, bag method (P_3) recorded significantly higher plant height (181.6 cm), number of tillers per plant (110.3), number of leaves per plant (737.1), number of roots per plant (317.0), dry root weight (95.1 g/plant), dry root yield (4085.8 kg/ha)and essential oil yield (85.3 kg/ha) compared to other planting methods. The better growth and higher root yield in bag method may be due to better rhizospheric environment provided to the growing plants, easy penetration of roots into the soil and inturn easy growth of roots and optimum utilization of supplied nutrients and less leaching losses. These findings of the present investigation are in conformity with the findings of Boonklinkajorn and Visuttipitakul (2001) [2] and Tiwari (2014) [11].

Among the different levels of fertilizers, the higher dose of fertilizer (F_6- 75:50:25 kg N, P_2O_5 and K_2O per ha recorded significantly higher plant height (180.1 cm), number of tillers per plant (111.2), number of leaves per plant (739.2), number of roots per plant (261.0), dry root weight (86.3 g/plant), dry root yield (3686.5 kg/ha) and essential oil yield (78.4 kg/ha) compared to other fertilizer levels. However, least plant height (174.1 cm), number of tillers per plant (100.7), number

of leaves per plant (674.9), number of roots per plant (215.4), dry root weight (69.8 g/plant), dry root yield (3047.2 kg/ha) and essential oil yield (62.6 kg/ha) were found with 25:25:25 kg NPK/ha (F_1). Higher values in growth, yield attributes and increased root yield under increased level of nutrients (F_6) could be attributed to better synthesis of metabolites due to application of higher levels of fertilizes in combination with farm yard manure (FYM). This has helped in enhancing the uptake of nutrients by the plants and accelerated the metabolic activates leading to greater accumulation of photosynthates inturn gave maximum dry matter production. The photosynthates which are synthesized in the leaves are translocated to the roots resulting in increased growth of yield components accounting for maximisation of final root yield. Increased root yield was also related to better vegetative growth of plants in terms of plant height, number of tillers and number of leaves which had positive and significant correlation with yield. Consistently least root yield was recorded in F_1 (25:25:25 kg NPK/ha) which could be attributed to least production of metabolites, less uptake of nutrients, poor vegetative growth and yield attributes. These findings are in conformity with the findings of Mohd Yaseen *et al.* (2014) [6], Priyadarshani *et al.* (2013) [9] and Rashmi and Singh (2008) [10].

The interaction effects were also found significant. The bag method (P_3) with fertilizer levels of 75:50:25 kg NPK/ha (F_6) recorded significantly higher plant height (184.95 cm), number of tillers per plant (115.9), number of leaves per plant (763.53), number of roots per plant (350.4), dry root weight (103.29 g/plant), dry root yield (4333.52 kg/ha) and essential oil yield (94.25 kg/ha) compared to all other interactions. These findings are well corroborated with the findings of Man Singh *et al.* (2002) [5], Patra *et al*. (2004) [7] and Priyadarshani *et al.* (2013) [9].

Table 1: Growth parameters of vetiver as influenced by planting methods, nutrition and their interaction at harvest

Treatments	Plant height (cm)	Number of tillers per plant	Number of leaves per plant
Main plot - Planting methods (P)			
P_1: Ridge & furrow	172.4	100.1	673.1
P_2: Bed	176.2	106.1	710.5
P_3: Bag	181.6	110.3	737.1
S.Em ±	1.59	1.30	4.49
C.D. @ 5%	4.89	3.91	13.47
Sub plot - Fertilizer levels (F)			
F_1: 25:25:25 kg NPK/ha	174.1	100.7	674.9
F_2: 50:25:25 kg NPK/ha	175.4	103.5	699.9
F_3: 75:25:25 kg NPK/ha	179.2	108.7	729.5
F_4: 25:50:25 kg NPK/ha	174.8	102.2	683.6
F_5: 50:50:25 kg NPK/ha	176.7	106.6	714.4
F_6: 75:50:25 kg NPK/ha	180.1	111.2	739.2
S.Em ±	1.02	0.72	1.58
C.D. @ 5%	3.10	2.44	4.89
Interaction (P × F)			
P_1 F_1	170.14	95.4	639.18
P_1 F_2	169.32	96.8	667.99
P_1 F_3	175.24	104.0	696.80
P_1 F_4	170.92	97.3	651.91
P_1 F_5	172.82	101.3	678.71
P_1 F_6	175.96	105.7	704.19
P_2 F_1	173.38	101.8	682.06
P_2 F_2	175.82	104.6	700.82
P_2 F_3	178.11	109.3	732.31
P_2 F_4	173.83	101.9	680.09
P_2 F_5	176.54	107.2	718.24
P_2 F_6	179.45	111.9	749.73
P_3 F_1	178.77	105.0	703.50
P_3 F_2	181.09	109.1	730.97
P_3 F_3	184.30	112.8	759.46
P_3 F_4	179.54	107.3	718.91
P_3 F_5	180.77	111.4	746.38
P_3 F_6	184.95	115.9	763.53
S.Em ±	1.83	1.44	4.41
C.D. @ 5%	5.11	4.12	12.91

Table 2: Yield and yield attributing characters and essential oil content of vetiver as influenced by planting methods, nutrition and their interaction at harvest

Treatments	No. of roots per plant	Root weight (g/plant)	Root yield (kg/ha)	Essential oil content (%)	Essential oil yield (kg/ha)
Main plot: Planting methods (P)					
P_1: Ridge & furrow	165.8	55.2	2406.3	2.0	47.6
P_2: Bed	229.9	81.4	3483.6	2.0	71.0
P_3: Bag	317.0	95.1	4085.8	2.1	85.3
S.Em ±	5.49	2.15	135.06	0.001	3.09
C.D. @ 5%	16.36	6.78	421.55	NS	9.76
Sub plot: Fertilizer levels (F)					
F_1: 25:25:25 kg NPK/ha	215.4	69.8	3047.2	2.0	62.6
F_2: 50:25:25 kg NPK/ha	224.7	72.9	3116.7	2.0	63.3
F_3: 75:25:25 kg NPK/ha	237.1	73.5	3152.9	2.1	65.2
F_4: 25:50:25 kg NPK/ha	236.4	80.0	3412.0	2.0	69.0
F_5: 50:50:25 kg NPK/ha	250.5	80.8	3536.0	2.0	69.3
F_6: 75:50:25 kg NPK/ha	261.0	86.3	3686.5	2.1	78.4
S.Em ±	3.54	1.79	61.70	0.001	1.65
C.D. @ 5%	10.85	5.84	190.36	NS	4.99
Interaction (P × F)					
P_1 F_1	150.4	48.05	2176.23	1.992	43.35
P_1 F_2	157.7	50.36	2076.05	1.976	41.02
P_1 F_3	165.1	49.63	2274.14	2.055	46.73
P_1 F_4	160.3	57.38	2479.38	1.933	47.93
P_1 F_5	175.6	60.26	2603.83	1.926	50.15
P_1 F_6	185.4	65.45	2828.09	1.991	56.31
P_2 F_1	212.4	73.89	3192.78	2.093	66.82
P_2 F_2	219.1	76.19	3292.16	1.906	62.75
P_2 F_3	232.6	77.54	3150.49	2.184	68.81
P_2 F_4	227.3	83.37	3602.41	1.906	68.66
P_2 F_5	240.7	87.15	3765.74	1.976	74.41
P_2 F_6	247.1	90.21	3897.96	2.170	84.59
P_3 F_1	283.5	87.31	3772.65	2.059	77.68
P_3 F_2	297.4	92.15	3981.79	2.163	86.13
P_3 F_3	313.6	93.36	4034.07	1.988	80.20
P_3 F_4	321.7	99.14	4154.20	2.174	90.31
P_3 F_5	335.2	95.09	4238.46	1.969	83.46
P_3 F_6	350.4	103.29	4333.52	2.175	94.25
S.Em ±	7.11	2.77	55.66	0.001	3.01
C.D. @ 5%	22.58	7.41	167.42	NS	9.55

Conclusion

Thus, based on the study it can be concluded that for commercial production of vetiver the bag method of planting with the fertilizer level of 75:50:25 kg NPK/ha along with farm yard manure (FYM) at the rate of 10 tonnes per ha is found suitable for getting higher root yield and also maximum essential oil yield in vetiver.

References

1. Archana Pareek, Ashwani Kumar. Ethno botanical and pharmaceutical uses of *Vetiveria zizanioides* (Linn) Nash: A medicinal plant of Rajasthan. Life Sci. 2013; 3(4):12-18.
2. Boonklinkajorn P, Visuttipitakul S. Root yield of vetiver grown in pot and polyethylene bag. Research Report, Plant Science Group, Agricultural Research Institute, Applied Scientific Research Corporation of Thailand, Bangkok, Thailand. 2001, 11.
3. Gomez KA, Gomez AA. Statistical procedures for agricultural research. 2nd Ed, John Willey and Sons, New York. 1984, 680.
4. Harshavardhan M, Kumar DP, Yathindra HA, Rajesh AM, Shivanand Hongal. Influence of integrated nutrient management on flower quality, yield and post harvest behavior of carnation (*Dianthus caryophyllus* L.) under polyhouse condition. Environment and Ecology. 2016; 34(4):1857-1861.
5. Man Singh, Singh VP, Saudan Singh, Pradeep Saini. Optimization of planting method, population density and phosphorus fertilization in vetiver (*Vetiveria zizanioides* Linn.) J. Med. Arom. Pl. Sci. 2002; 24(2):410-412.
6. Mohd Yaseen, Man Singh, Dasha Ram. Growth, yield and economics of vetiver (*Vetiveria zizanioides* L. Nash) under intercropping system. Industrial Crops and Products. 2014; 61:417-421.
7. Patra DD, Sukhmal Chand, Singh A, Anwar M, Lal RK, Singh S *et al*. Agrotechnology of vetiver (*Vetiveria zizanioides* (L.) Nash). J. Med. Arom. Pl. Sci. 2004; 26(4):784-789.
8. Prakasa Rao EVS, Gopinath CT, Khanuja SPS. Environmental, economics and equity aspects of vetiver in south India.Bulletin, CSIR- Central Institute of

Medicinal and Aromatic Plants Resource Centre, Bengaluru. 2011.
9. Priyadarshani NDN, Amarasinghe, MKTK, Subasinghe S, Palihakkara IR, Kumarasinghe HKMS. Effect of organic and inorganic fertilizers on biomass production, oil yield and quality of vetiver (*Vetiveria zizanioides*), J. Agric. Res. 2013; 8(1):24-29.
10. Rashmi, Singh SB. Studying the effect of nitrogen and potassium fertilizer on growth and essential oil content of *Cymbopogon citratus* and *Vetiveria zizanioides*. J. Essential Oil Bearing Pl. 2008; 11(2):188-193.
11. Tiwari JP. Development and field evaluation of khus root digger at CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow. Agril. Engg. Today. 2014; 38(3):1-4.