Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; SP3: 135-140

M Shivaprasad
Professor of Agronomy and Associate Director of Research ZAHRS, Mudigere, Chikkamagalur, Karnataka, India

BM Chittapur
Professor of Agronomy, UAS, Raichur, Karnataka, India

Sadashiva Nadukeri
Assistant Professor (PSMAC), COH, Mudigere, Karnataka, India

CS Ravi
Assistant Professor (PSMAC), ZAHRS, Mudigere, Karnataka, India

HR Bhomika
Assistant Professor (PSMAC), COH, Mudigere, Karnataka, India

Correspondence
M Shivaprasad
Professor of Agronomy and Associate Director of Research ZAHRS, Mudigere, Chikkamagalur, Karnataka, India

National conference on "Conservation, Cultivation and Utilization of medicinal and Aromatic plants"
(College of Horticulture, Mudigere Karnataka, 2018)

Effect of nitrogen substitution and biorational sprays on the quality, oleoresin content and yield of the bydagi chilli

M Shivaprasad, BM Chittapur, Sadashiva Nadukeri, CS Ravi and HR Bhomika

Abstract
The field experiment was conducted during 2009 and 2010 to study the effect of nitrogen (N) substitution, biorationals and plant extract sprays on quality, oleoresin content and yield of bydagi chilli. Recommended fertilizer (RDF @ 100:50:50 kg NPK ha-1) and 50:50:50 kg ha^{-1} NPK through fertilizers and remaining 50 % N substitution equally through 2.5 t ha^{-1} Vermicompost and 500 kg ha^{-1} neem cake as main treatment and seven biorationals, silica, recommended plant protection chemical (RPP) and absolute control formed subplot treatments. Significantly higher dry pod yield was recorded with integrated N supply (795 kg ha^{-1}) compared to RDF. Among the biorational sprays, alternate sprays of Abamectin (3 sprays) and Perfect (2 sprays) produced higher yield by nearly 44 per cent over chilli grown with RPP sprays (two sprays of Dimethoate @1.7 ml l^{-1} + 2 sprays of Dicofal @ 2.5 ml l^{-1} + Carbaryl @ 4g l^{-1}). The quality parameters such as oleoresin content (%), oleoresin yield, Ascorbic acid content, Capsaicin content, Scovielle heat unit and Percent discoloured fruits followed the same trend as pod yield.

Keywords: Neem cake, RDF, Nimbicidine, Panchagavya, Abamectin, RPP, Perfect. Oleoresin, Ascorbic acid, Capsaicin and Scovielle heat unit

Introduction
India is the largest producer of chilli crop, grown on an area of 2, 68,000 ha with an annual production of 3, 21,000 tonnes with the productivity of 1198 kg ha^{-1}. Karnataka ranks second in area (89,556 ha) and production (1, 11,547 tonnes) of dry chilli after Andhra Pradesh (Anon, 2016) [1]. During the last two decades insecticidal control of chilli pests characterized by high pesticide usage has posed problem of residue in the fruits. Infact, both significant domestic consumption and sizable export of chilli necessitate production of quality chillies devoid of contamination of pesticides, industrial chemicals and aflatoxins. But the presence of residues in spices in general and in chilli in particular has been a major non-tariff barrier against export of chillies to the developed countries. The reported presences of residues of many insecticides including ethion, chlorpyriphos, cypermethrin, endosulfan and quinalphos have seriously affected the export of chillies. Chilli consignments are detained at the ports of the importing countries very often due to high pesticide usage in India. Besides, indiscriminate use of insecticides has led to insecticide resistance, pest resurgence, environmental pollution and upsetting of natural ecosystem. To overcome these problems, use of Biopesticides spray, plant based substances and certain indigenous practices offer safe alternatives in pest management. The integrated use of nutrients is better for the better quality of the vegetable crops such as bitter gourd. The use of Organic nutrient sources such as vermicompost help for better growth and development of the crop and impart resistance to the crop against pest and diseases. In view of this an investigation was carried out to evaluate effect of nitrogen substitution and biorational sprays on the quality, oleoresin content and yield of the bydagi chilli.

Materials and methods

A field experiment was conducted at Horticultural Research Station, Devihosur, Haveri, UAHS, Bagalkot during growing seasons of 2009 and 2010 at fixed site using spilt plot design with three replications with RDF (100:50:50 kg NPK ha^{-1}, entire N through fertilizer) and 50:50:50 kg ha-1 NPK; 50% of 100 kg N through Calcium Ammonium Nitrate (CAN) and remaining 50% N through 2.5 t ha^{-1} vermicompost and 500 kg ha^{-1} neem cake as main plots, and biorational sprays namely alternate sprays of Nimbicidine (5 ml l^{-1}) and Garlic-Chilli Kerosene extract (GCK) (1%), leaf extract (10%), Panchagavya (3%), leaf extract (10%) + Panchagavya (3%) mixture, Silica (2 ml l^{-1}), Action (1ml l^{-1}), alternate sprays of Abamectin (0.5 ml l^{-1}) and Perfect (1 ml^{-1}), only Silica dusting and soil application (3,5,7,9 and 11 WAT) and RPP (two sprays of Dimethoate (1.7 ml1^{-1}) at 2 and 5 WAT, Dicofal (2.5 ml l^{-1}) + Carbaryl (4g l^{-1}) at 7 and 11 WAT and control(water spray) as sub plot treatment having no sprays. Microbial cultures of *Pseudomonas fluorescence*, *Azotobacter*, *Azospirillum* and PSB (P solubilizing bacteria) were mixed with 10 litres of water and seedlings were dipped in these solutions for one hour before transplanting. The Panchagavya was prepared by the following procedure, cow dung (7 kg) + cow ghee (1 kg) → incubated 2 days → added 3 litres of cow urine + 10 litres water → stirred 2 times per day for 1 week → added sugarcane juice (3 litres) → added cow urine (2 litres) → added cow curd (2 litres) → added coconut water (3 litres) → added yeast (100 g) + 12 ripped banana → incubated for 2 weeks. After these incubation periods panchagavya was used for spray. The leaves of nigundo (*Vitex nigundo* @ 1 kg), neem (*Azadirachta indica* @ 1 kg), NSKE (Neem seed kernel extract @ 1kg), *Adothoda vesica* @ 1kg, pongamia (*Pongamia pinnata* @ 1kg) and argemone (*Argemone mexicana* @ 1kg) were chopped → added 100 ml cow urine + 10 litres of water → incubated for 4 weeks, filtered with muslin cloth and solution was used for spray. Garlic bulbs (10 g) and green chilli pods (10 g) were thoroughly ground separately in a pestle and mortar; grind materials were soaked overnight in 10 ml kerosene each separately. Next day, the extracts of garlic and chilli were mixed and filtered through muslin cloth. Later, the volume was made up to 1 litre to obtain 1 per cent garlic-chilli-kerosene (GCK) extract. The soil of the experimental site was medium deep black soil, neutral (7.2 pH) with 272.0, 36.6 and 336.0 kg ha^{-1}, respectively available nitrogen, phosphorus and potassium and 0.56 per cent organic carbon. In general, the experiment site was medium in fertility status.

For the estimation of quality parameters samples of red ripe fruits from all pickings were collected treatment-wise for determining quality traits. They were sun dried for 10-15 days till they were brittle and then distilled carefully. The sun dried fruits were used for the analysis of capsaicin and oleoresin. For the estimation of the ascorbic acid content freshly harvested green chilli was used for ascorbic acid estimation. It was determined volumetrically by reducing 2, 6-dichlorophenol-indophenol dye to get a pink end point (Sadasivam and Manikam, 1992) [10]. The Capsaicin content and Scovielle Heat Unit (SHU) was estimated by the procedure proposed by Palacio (1977) [7]. In this estimation procedure, 2 grams of ground-dried chilli was passed through No.40 sieve (0.42 mm) and was placed in the 100 ml volumetric flask. The material was diluted with ethyl acetate up to 100 ml and allowed it to stand for 24 hours to extract. One ml of the extract was taken and diluted with 5 ml of ethyl acetate just before reading, and then 0.5 ml of vanadium oxytrichloride ($VoCl_3$) solution (0.5% $VoCl_3$ in ethyl acetate) was added and the volumetric flask (100 ml) was shaken thoroughly and reading was taken at 720 nm. Then reading was subtracted from the value obtained with 0.5 ml $VoCl_3$ added to 5 ml ethyl acetate (blank) and the reading was compared with the standard curve prepared for capsaicin. The amount of capsaicin in the samples was expressed in percentage. The capsaicin content in fruits is expressed in terms of Scovielle heat units (Scovielle, 1912) [11]. Suzuki *et al.* (1957) [13] have established the relationship that one per cent of pure capsaicin has a Scovielle heat value of 150000 units

$$\%\ \text{capsaicin} = \frac{\text{mg capsaicin}}{1000 \times 1000} \times \frac{100}{1} \times \frac{100}{2}$$

The Oleoresin content was estimated by taking ten grams of chilli powder sample in a chromatographic column, plugged with stop cock. Fifty ml of acetone was added and allowed over night. The slurry was collected in a pre-weighed beaker and solvent was evaporated over a water bath. The collected slurry was cooled and weighed. Difference in weight over sample weight was expressed as per cent oleoresin (AOAC, 1997) or (ASTA method 2.3). Oleoresin yield per ha was worked out by using the formula.

Oleoresin yield (kg ha^{-1}) =

$$\underset{(\text{kgha}^{-1})}{\text{Fruit yield}} - \underset{\text{weight (kg ha}^{-1})}{\text{discoloured fruit}} \times \frac{\text{Oleoresin per cent in fruits}}{100}$$

Results and discussion

Performance of chilli Supplementing 50 per cent of RDN equally through 2.5 t ha^{-1} vermicompost + 500 kg ha-1 neem cake (25 kg ha^{-1} N each) recorded the highest yield of chilli (795 kg ha-1) with yield improvement to the extent of 22 per cent over complete inorganic source of N application. Similar results of increased yield due to application of organics in combination with inorganic (RDF) in 1:1 ratio compared to the inorganic fertilizer alone were reported by Shashidhara and with the use of neem cake by Ravikumar and Gundannavar. Similarly, Sharu and Meerabai reported significant improvement in the yield components with the combination of organic and inorganic sources of nutrients (N) to chilli crop. Among plant protection schedules, alternate spray of Abamectin and Perfect at 3, 5, 7, 9 and 11 WAT recorded highest dry pod chilli yield (1050 kg ha^{-1}). Interestingly, improvement in the yield was to the extent of 54 per cent over recommended chemical spray (Dimethoate + Dicofal + Carbaryl spray) and more than double (119%) over control treatment having no sprays (Table 1). The beneficial effect of Abamectin in increasing yield was also reported by Tatagar. Nimbicidine alternated with GCK, leaf extract or panchagavya + leaf extract and panchagavya alone were next in the order and were on par with RPP Gundannavar opined that neem products are best alternatives to RPP with on par/higher chilli yield. Similarly, Kulkarni and Shekarappa reported higher yield of chilli through NSKE. Thus, the results clearly evident that integrated supply of nitrogen nutrient through organic and inorganic sources together with biorational spray (e.g. Abamectin-Perfect, Nimbicidine- Leaf extract + Panchagavya) has got remarkable influence on yield and quality of Bydagi chilli compared to only inorganic sources of N nutrition. Chilli crop supplied with integrated sources of nitrogen through organic and inorganic sources coupled with Abamectin and Perfect sprays alternatively recorded the highest fruit yield (1131 kg ha^{-1}) and the increment was appreciable which was to the extent of 63 and 164 per cent over RPP and no spray treatment receiving only inorganic source of nitrogen, respectively. Alternate spray of Abamectin and Perfect coupled with inorganic source N application was next in the order.

Chilli quality was greatly influenced by application of integrated sources of N through organics and inorganic. Among the quality parameters the ascorbic acid content of the chilli fruit was the highest with the combined application of N through organic Similar to the above findings, Finch and Popokaya also observed the inverse relationship between ascorbic acid content and inorganic sources of N. Among the biorational and leaf extract sprays the highest ascorbic acid content was recorded with Nimbicidine alternated with leaf extract + Panchagavya spray (216.4 mg 100 g^{-1}). This was closely followed by alternate spray of Abamectin and perfect, both were at par. The nimbecidine alternated with leaf extract + Panchagavya enhanced the ascorbic acid content to extent of 60 and 73 per cent compared to RPP and control treatment having no sprays respectively. While, the extent of improvement with alternate spray of Abamectin and Perfect was 32 and 62 per cent over RPP and no spray treatment, respectively. Similar trend was observed with capsaicin content and Scovielle heat units (SHU). The integrated nitrogen management through equal quantity of N through organic and inorganic sources improved the capsaicin content and SHU to the extent of 25 and 23 per cent, respectively compared to only inorganic sources of N application. The oleoresin per cent and oleoresin yield (15.56% and 113.9 kg ha^{-1}, respectively) increased significantly with 50 per cent of N substitution through organics in the form of vermicompost and neem cake compared to inorganic source of N nutrition. The improvement in the oleoresin content and yield with the integrated N supply was to the extent of 8 and 32 per cent compared to only inorganic sources of N application. Nimbicidine alternated with leaf extract + Panchagavya spray recorded significantly higher capsaicin and Scovielle heat units and increase was to the extent of 120 and 214 per cent and 115 and 204 per cent compared to RPP and no spray (control) treatments, respectively (Table 2). The oleoresin per cent was significantly higher (17.48%) with alternate spray of Nimbicidine and leaf extract + Panchagavya spray compared to rest of the sprays except alternate spray of Abamectin and Perfect (16.51%). The alternate spray of Abamectin and Perfect recorded the highest oleoresin yield (160 kg ha^{-1}) and the increment in the oleoresin yield was to the extent of 67 and 203 per cent over RPP and no spray treatment (control), respectively (Table 3). In the present study, it was clearly evident that integrated supply of nitrogen nutrient through organic and inorganic sources together with biorational spray (e.g: Abamectin-Perfect, Nimbicidine- Leaf extract + Panchagavya) has got remarkable influence on yield and quality of Bydagi chilli.

Table 1: Yield of the *Bydagi* chilli as influenced by nitrogen substitution through organics and use of biorational and plant extract sprays (Pooled data of 2009 and 2010).

Treatments	Dry pod yield (kg/ha)
T_1:100:50:50 kg NPK ha^{-1} (RDF)*	654^b
T_2:50:50:50 kg ha^{-1} NPK + 50% N by 2.5 t ha^{-1} V.C + 500 kg ha^{-1} neem cake**	795^a
S.Em.±	8.9
C.D at5%	79.5
S_1: Nimbecidine – GCK	750^b
S_2: Nimbecidine – Leaf extract	768^b
S_3: Nimbecidine - Panchagavya	741^b
S_4: Nimbecidine – Leaf extract +Panchagavya mixture spray	782^b
S_5: Nimbecidine - Silica spray	636^c
S_6: Nimbecidine - Action 100 spray	614^c
S_7: Abamectin (1.9 EC) - Perfect	1050^a
S_8: Silica	665^c
S_9: RPP	758^b
S_{10}: Control	479^d
S.Em.±	19.9
C.D at 5%	56.2
T_1S_1	677^{de}
T_1S_2	695^d
T_1S_3	668^{de}
T_1S_4	712^d
T_1S_5	558^f
T_1S_6	538^f
T_1S_7	969^b
T_1S_8	604^{ef}
T_1S_9	693^d
T_1S_{10}	428^g
T_2S_1	823^c
T_2S_2	841^c
T_2S_3	814^c
T_2S_4	853^c
T_2S_5	714^d
T_2S_6	691^d
T_2S_7	1131^a
T_2S_8	724^d

T_2S_9	822 c
T_2S_{10}	532 f
S.Em.±	28.2
C.D at 5%	79.5

* Inorganic N, ** Organic + inorganic N (50:50), *** Chemical sprayed alternatively Silica (2 ml l^{-1}), nimbecidine (5 ml l^{-1}), GCK (Garlic chilli kerosene extract 1%), leaf extract (*Vitex nigundo*, *Azadirachta inidca*, *Adothoda vesica*, *Pongamia pinnata*, *Argimone mexicana* and NSKE), Abamectin (0.5 ml l^{-1}), perfect (1 ml l^{-1}), panchagavya (3%), In a column means followed by the same alphabet do not differ significantly by DMRT (0.05)

Table 2: Ascorbic acid content (mg 100 g^{-1}), capsaicin content (%) and Scovielle heat units as influenced by nitrogen substitution through organics and use of biorational and plant extract sprays (Pooled data of 2009 and 2010).

Treatments	Ascorbic acid content (mg 100 g^{-1})	Capsaicin content (%)	Scovielle heat units
Sources of Nitrogen			
T_1:100:50:50 kg NPK ha^{-1} (RDF)*	161.5 b	01.2 b	18025 b
T_2:50:50:50 kg ha^{-1} NPK + 50% N by 2.5 t ha^{-1} V.C + 500 kg ha^{-1} neem cake**	178.9 a	0.15 a	22250 a
S.Em.± C.D at5%	1.9 5.3	0.004 0.012	449.3 1267
Biopesticides sprays***			
S_1: Nimbecidine – GCK	177.3 c	0.15 bc	22500 bc
S_2: Nimbecidine – Leaf extract	190.8 b	0.14 cd	20625 cd
S_3: Nimbecidine - Panchagavya	195.7 b	0.17 b	24875 b
S_4: Nimbecidine – Leaf extract +Panchagavya mixture spray	216.4 a	0.22 a	32250 a
S_5: Nimbecidine - Silica spray	144.7 ef	0.12 de	18125 de
S_6: Nimbecidine - Action 100 spray	160.8 d	0.11 e	16500 ef
S_7: Abamectin (1.9 EC) - Perfect	202.4 b	0.17 b	24750 b
S_8: Silica	135.7 fg	0.11 e	16125 ef
S_9: RPP	153.6 de	0.10 e	15000 f
S_{10}: Control	125.1 g	0.07 f	10625 g
S.Em.±	4.2	0.01	1005
C.D at 5%	11.9	0.03	2832
Interaction			
T_1S_1	177.6 def	0.14 cde	20250 def
T_1S_2	177.9 def	0.12 d-g	17250 fgh
T_1S_3	183.2 cde	0.16 cd	23250 cde
T_1S_4	198.5 bc	0.20 ab	30000 b
T_1S_5	138.9 ijk	0.10 e-h	15250 ghi
T_1S_6	153.0 ghi	0.09 fgh	13250 hij
T_1S_7	193.3 bcd	0.16 cd	23250 cde
T_1S_8	130.7 kl	0.10 e-h	14250 g-j
T_1S_9	145.9 h-k	0.09 fgh	13500 g-j
T_1S_{10}	116.3 l	0.07 h	10000 j
T_2S_1	177.1 def	0.16 cd	24750 cd
T_2S_2	203.6 b	0.16 cd	24000 cde
T_2S_3	208.2 b	0.18 bc	26500 bc
T_2S_4	234.2 a	0.23 a	34500 a
T_2S_5	150.4 g-j	0.14 cde	21000 def
T_2S_6	168.3 efg	0.13 def	19750 ef
T_2S_7	211.6 b	0.18 bc	26250 bc
T_2S_8	140.7 ijk	0.12 d-g	18000 fg
T_2S_9	161.4 fgh	0.11 e-h	16500 fgh
T_2S_{10}	133.9 jkl	0.08 gh	11250 ij
S.Em.±	6.0	0.01	1421
C.D at 5%	16.9	0.04	4006

* Inorganic N, ** Organic + inorganic N (50:50), *** Chemical sprayed alternatively Silica (2 ml l^{-1}), nimbecidine (5 ml l^{-1}), GCK (Garlic chilli kerosene extract 1%), leaf extract (*Vitex nigundo*, *Azadirachta inidca*, *Adothoda vesica*, *Pongamia pinnata*, *Argimone mexicana* and NSKE), Abamectin (0.5 ml l^{-1}), perfect (1 ml l^{-1}) panchagavya (3%), In a column means followed by the same alphabet do not differ significantly by DMRT (0.05).

Table 3: Oleoresin content (%) and Oleoresin (kg ha^{-1}) as influenced by nitrogen substitution through organics and use of biorational and plant extract sprays (Pooled data of 2009 and 2010).

Treatments	Oleoresin content (%)	Oleoresin (kg ha^{-1})
Sources of nitrogen		
T_1:100:50:50 kg NPK ha^{-1} (RDF)*	14.47 ^{b}	86.2 ^{b}
T_2:50:50:50 kg ha^{-1} NPK + 50% N by 2.5 t ha^{-1} V.C + 500 kg ha^{-1} neem cake**	15.56 ^{a}	113.9 ^{a}
S.Em.±	0.17	1.70
C.D at5%	0.49	4.78
Biopesticides sprays		
S_1: Nimbecidine – GCK	15.82 ^{bc}	107.8 ^{c}
S_2: Nimbecidine – Leaf extract	15.05 ^{cd}	103.9 ^{cd}
S_3: Nimbecidine - Panchagavya	14.76 ^{cd}	99.6 ^{cde}
S_4: Nimbecidine – Leaf extract +Panchagavya mixture spray	17.48 ^{a}	125.6 ^{b}
S_5: Nimbecidine - Silica spray	15.00 ^{cd}	90.6 ^{efg}
S_6: Nimbecidine - Action 100 spray	14.44 ^{d}	79.7 ^{g}
S_7: Abamectin (1.9 EC) - Perfect	16.51 ^{ab}	159.8 ^{a}
S_8: Silica	14.31 ^{d}	85.2 ^{fg}
S_9: RPP	14.16 ^{d}	95.5 ^{def}
S_{10}: Control	12.47 ^{e}	52.8 ^{h}
S.Em.±	0.39	3.79
C.D at 5%	1.10	10.69
Interaction		
T_1S_1	15.41 $^{b-f}$	94.2 ^{efg}
T_1S_2	14.59 $^{c-h}$	90.7 ^{fgh}
T_1S_3	13.79 ^{fgh}	83.1 ^{ghi}
T_1S_4	17.09 ^{ab}	111.5 ^{cd}
T_1S_5	14.4 $^{c-h}$	72.4 ^{ij}
T_1S_6	13.41 ^{ghi}	63.7 ^{j}
T_1S_7	16.06 ^{bcd}	142.9 ^{b}
T_1S_8	14.01 $^{c-h}$	74.8 ^{hij}
T_1S_9	13.96 $^{c-h}$	84.9 ^{ghi}
T_1S_{10}	11.98 ^{i}	43.8 k
T_2S_1	16.23 ^{abc}	121.3 ^{c}
T_2S_2	15.51 $^{b-f}$	117.1 ^{c}
T_2S_3	15.74 $^{b-e}$	116.2 ^{c}
T_2S_4	17.87 ^{a}	139.8 ^{b}
T_2S_5	15.61 $^{b-f}$	108.8 ^{cde}
T_2S_6	15.47 $^{b-f}$	95.8 $^{d-g}$
T_2S_7	16.97 ^{ab}	176.6 ^{a}
T_2S_8	14.85 $^{c-g}$	95.5 $^{d-g}$
T_2S_9	14.37 $^{d-h}$	106.1 $^{c-f}$
T_2S_{10}	12.97 ^{hi}	61.9 ^{j}
S.Em.±	0.55	5.36
C.D at 5%	1.55	15.11

* Inorganic N, ** Organic + inorganic N (50:50), *** Chemical sprayed alternatively Silica (2 ml l^{-1}), nimbecidine (5 ml l^{-1}), GCK (Garlic chilli kerosene extract 1%), leaf extract (*Vitex nigundo*, *Azadirachta inidca*, *Adothoda vesica*, *Pongamia pinnata*, *Argimone mexicana* and NSKE), Abamectin (0.5 ml l^{-1}), perfect (1 ml l^{-1}) panchagavya (3%), In a column means followed by the same alphabet do not differ significantly by DMRT (0.05)**.**

References

1. Anonymous. Commodity watch group of India, 2016. *www.capitalmarket.com*
2. Chakraborti S. Neem based integrated schedule for the control of vectors causing apical leaf curling in chilli. Pest Management and Eco. Zoology. 2000; 8:79-84.
3. Finch AH. The influence of nitrogen upon the ascorbic acid content of several vegetable crops. Proceedings of American Society of Hort. Sci. 1945; 46:314.
4. Gundannavar KP. Vector-leaf curl relationship and development of organic package for the management of chilli (*Cv.Bydagi)* pests. Ph.D. Thesis, University of Agricultural Sciences, Dharwad, 2007.
5. Kulkarni JS, Shekarappa. Integrated management of chilli fruit borer *Helicoverpa armigera* Hub. Proceedings of II National Symposium on Integrated Pest Management (IPM) in Horticulture Crops: New Molecules, Biopesticides and Environment, Bangalore, 17-19th, 2001, 59-60.
6. Meerabai M, Asha KR. Biofarming in vegetables. Kisan World, 2001; 28:15-16.
7. Palacio JJR. Flavour and non-alcoholic beverages spectrophotometric determination of capsaicin. J.A.O.A.C. 1977; 60(4):970-972.
8. Popokaya EM. The role of nitrogen and water regime in the formation and accumulation of ascorbic acid in tomatoes. *Boihhimija*, 1957; 17:145-150.
9. Ravikumar. Evaluation of organics and indigenous products for the management of soybean pod borer complex with special reference to Cydia ptychora (Myrick). M.sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad, 2004.
10. Sadasivam S, Manikam A. Biochemical Methods for Agricultural Sciences, Wiley Eastern, Limited, New Delhi, 1992, 178-192.
11. Scovielle WL. Heal unit test of pungency from ASTA

schedule B for four cultivars grown in Texas, USA. Journal of American Pharmacists Association. 1912; 1:453.
12. Sharu SR, Meerabai M. Effect of integrated nutrient management on yield and quality in chilli (Capsicum annuum L.). Veg. Sci. 2001; 28:184-185.
13. Suzuki JJ, Tausing F, Morse RE. Some observations on red pepper. A new method for the determination of pungency in red pepper. Food Technology. 1957; 41:100.