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Effect of Nitrogen Substitution through Organics and Use of Biorational and Plant Extract Sprays on the Yield and Quality Chilli

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ABSTRACT

The field experiment was conducted during 2009 and 2010 to study the effect of nitrogen (N) substitution, biorationals and plant extract sprays on yield of chilli and behavior of leaf curl (murda) complex. 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 good quality fruits 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}), due to reduced the leaf curl disease to the extent of 58 per cent over RPP and almost by 279 per cent over crop without any protection measures.

Key words: *Chilli, Vermicompost, Neem cake, RDF, Nimbicidine, Panchagavya, Biorationals, Abamectin, RPP, and Perfect.*

INTRODUCTION

Chilli is one is an indispensable condiment as well as vegetable in every household of India and preparing curry powder and curry paste[2]. Among chilli cultivars, Bydagi is the most popular variety known for mild pungency, fruit colour, aroma, and oleoresin and other characteristics. These properties have given ample scope to export the produce to various countries across the globe. India is the largest producer of chilli crop, grown on an area of 0.96 million hectares with an annual production of 1.05 million tones with the productivity of 918 kg ha^{-1}. Karnataka ranks second in area (0.162 million ha) and production (0.109 million tones) of dry chilli after Andhra Pradesh. The current productivity levels are, however, far below the satisfactory level to meet even the domestic demand particularly due to poor nutrient management, viral diseases and the ravages caused by insect pests.

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During the last two decades insecticidal control of chilli pests characterized by high pesticide usage has posed problem of residue in the fruits[5]. 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[7]. To overcome these problems, use of Biopesticides spray, plant based substances and certain indigenous practices offer safe alternatives in pest management[9]. The integrated use of nutrients is better for the better quality of the vegetable crops such as bitter gourd[15]. 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[8]. In view of this an investigation was carried out to evaluate effect of nitrogen substitution through organics and use of biorational and plant extract sprays on the yield and quality of chilli.

MATERIAL 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 liters 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 liters of cow urine + 10 liters water → stirred 2 times per day for 1 week → added sugarcane juice (3 liters) → added cow urine (2 liters) → added cow curd (2 liters) → added coconut water (3 liters) → 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 liters 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 upto 1 liter 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. The total annual rainfall during the season was 862.3 mm in 2005 and 684.4 mm during 2006. The observations on yield and yield parameters were recorded at the time of harvest. The leaf curl index was recorded by visual ratings (no curling- 0, low curling- 1 (1 to 25% curling), moderate curling- 2 (26 to 50% curling), heavy curling- 3 (51 to 75% curling), and very high curling- 4 (>75% curling)) on terminal leaves of five randomly selected plants in each plot, data pooled and overall rating was worked out.

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[11] and Gundannavar[4]. This yield improvement in integrated N use was mainly due to improved yield attributes. N supply equally through organic and inorganic sources significantly increased the number of fruits $hill^{-1}$ (11 %), fruit length (3 %), 100-fruit weight (5 %), 1000-seed weight (11 %) and seed to pod ratio (9 %) over crop supplied with inorganic source of N only (Table 1). Similarly, Sharu and Meerabai[13] 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. The beneficial effect of Abamectin in increasing yield was also reported by Tatagar[14]. Nimbecidine alternated with GCK, leaf extract or panchagavya + leaf extract and panchagavya alone were next in the order and were on par with RPP (Table 1). Gundannavar[4] opined that neem products are best alternatives to RPP with on par/higher chilli yield. Similarly, Kulkarni and Shekarappa[6] reported higher yield of chilli through NSKE. Thus, the results clearly emphasized the possibility of reducing pesticide load in the pest ridden crop like chilli. These practices also promise production of pesticide - free chilli, which is a major deterrent in the international market. Abamectin spray alternated with Perfect recorded significantly higher number of matured fruits, fruit length, 100-fruit weight, 1000-seed weight and seed to pod ratio over RPP (Table 1). Chakraborti[1] reported higher number of fruits per plant with neem based insecticides. Ultimate yield was the cumulative effect of all these components. Neem based sprays alternated with few biorationals were next in the order and were comparable with RPP.

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. Further yield components, which ultimately contributed to yield, were also better and statistically superior with this treatment.

Quality of Chilli

Chilli quality was greatly influenced by application of integrated sources of N through organics and inorganic. The ascorbic acid content of the chilli fruit was the highest with the combined application of N through organic and inorganic sources (178.9 mg 100 g^{-1}) compared to only inorganic sources of N nutrition. Similar to the above findings, Finch[3] and Popokaya[10] also observed the inverse relationship between ascorbic acid content and inorganic sources of N. 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

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. The capsaicin content and Scovielle heat units followed the trend of ascorbic acid content. Nimbecidine 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. 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.

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, Nimbecidine- Leaf extract + Panchagavya) has got remarkable influence on yield and quality of Bydagi chilli.

Economics of the chilli production

The highest gross return, net return and B: C ratio (Rs.39730, Rs.20900 ha^{-1} and 2.31, respectively) were recorded with the treatment having equal supply of N through organics (2.5 t ha^{-1} vermicompost + 500 kg ha^{-1} neem cake) and inorganic source (CAN) and 50 kg P_2O_5 and K_2O ha^{-1}.

Among the Biopesticides sprays, alternate spray of Abamectin and Perfect recorded the higher gross return, net return and B:C ratio (Rs.52,480, 31,510 ha^{-1} and 2.54, respectively), while RPP was next in the order. On the other hand, no spray treatment recorded the lowest gross return, net return and B: C ratio. The monetary benefit from alternate sprays of Abamectin and Perfect was Rs.11,100 and 22,930 ha^{-1} higher over RPP and no spray treatments, respectively.

Among the treatments combinations of N sources and Biopesticides sprays, the highest gross return was recorded with equal proportion of organic and inorganic sources of N coupled with alternate spray of Abamectin and Perfect (Rs. 56530 ha^{-1}). Only inorganic source of N application with alternate spray of Abamectin and Perfect was next in the order. Integrated source of N supply coupled with alternated spray of nimbecidine and leaf extract + Panchagavya, leaf extract or Panchagavya, and RPP were on par with one another. While, the lowest gross return was recorded with only inorganic sources of N application but without any sprays (Rs. 21,360 ha^{-1}).

Integrated supply of N through organic and inorganic sources coupled with alternate spray of Vertimac and Perfect recorded significantly higher net returns (Rs.34130 ha^{-1}). While, only inorganic N applied treatment with the above spray schedule was on par with the former treatment combination. On the other hand, irrespective of source of N, Nimbicidine alternated with GCK, Panchagavya, leaf extract + Panchagavya or leaf extract, and only RPP were next in the order, while significantly lower net return was recorded with only inorganic N supplied treatment but without any sprays (Rs. 9,360 ha^{-1}). Chilli crop nutritioned with equal doses of N through organic and inorganic sources coupled with alternate spray of Abamectin and Perfect recorded significantly higher B: C ratio (2.75). Because of high cost of Abamectin spray and cost of organics the integrated N supply through organic and inorganic sources with alternate spray of nimbecidine, GCK, leaf extract sprays and leaf extract + Panchagavya and alternate spray of Abamectin and prefect with only inorganic source of N were on par with the former treatment. Inorganic source of N application with alternate spray of Nimbicidine and leaf extract and integrated N supply with alternate spray of leaf extract + Panchagavya or RPP spray were next in the order. On the other hand, lower B: C ratio was recorded in the inorganic source of N applied plot but without any sprays (1.59).

Table 1: Yield and yield components of *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)	No. Fruits/hill	Fruit length (cm)	100 fruit weight (g)	1000 seed weight (g)	Seed to pod ratio
Sources of nitrogen						
T_1:100:50:50 kg NPK ha^{-1} (RDF)*	654^{b}	29.2^{b}	9.90^{b}	97.7^{b}	6.35^{b}	35.1^{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}	32.5^{a}	10.3^{a}	102.6^{a}	7.03^{a}	38.4^{a}
S.Em.±	8.9	0.47	0.07	0.90	0.06	0.49
C.D at5%	79.5	1.34	0.21	2.55	0.18	1.39
Biopesticides sprays* **						
S_1: Nimbecidine – GCK	750^{b}	33.3^{bc}	10.2^{bc}	99.8^{cd}	6.63^{c}	37.4^{bcd}
S_2: Nimbecidine – Leaf extract	768^{b}	35.3^{bc}	10.3^{bc}	103.7^{bc}	6.75^{c}	38.4^{b}
S_3: Nimbecidine - Panchagavya	741^{b}	32.5^{c}	10.3^{bc}	105.5^{bc}	6.90^{bc}	39.3^{b}
S_4: Nimbecidine – Leaf extract +Panchagavya mixture spray	782^{b}	36.2^{b}	10.4^{b}	106.5^{b}	7.27^{b}	40.7^{ab}
S_5: Nimbecidine - Silica spray	636^{c}	27.7^{d}	9.8^{cd}	96.2^{de}	6.13^{d}	33.9^{e}
S_6: Nimbecidine - Action 100 spray	614^{c}	25.1^{d}	9.8^{cd}	96.5^{de}	6.18^{d}	34.3^{de}
S_7: Abamectin (1.9 EC) - Perfect	1050^{a}	43.1^{a}	10.9^{a}	114.2^{a}	8.31^{a}	43.4^{a}
S_8: Silica	665^{c}	27.4^{d}	9.8^{cd}	92.0^{ef}	6.03^{d}	34.7^{cde}
S_9: RPP	758^{b}	35.5^{bc}	10.1^{bc}	99.8^{cd}	6.95^{bc}	37.8^{bc}
S_{10}: Control	479^{d}	12.4^{e}	9.3^{d}	87.5^{f}	5.76^{d}	27.5^{f}
S.Em.±	19.9	1.06	0.17	2.02	0.14	1.10
C.D at 5%	56.2	3.00	0.47	5.70	0.40	3.10
Interaction						
T_1S_1	677^{de}	31.1^{ef}	10.0^{b-f}	97.5^{d-h}	6.37^{fg}	35.3^{d-g}
T_1S_2	695^{d}	33.3^{de}	10.2^{b-f}	102.0^{b-g}	6.55^{efg}	36.7^{c-g}
T_1S_3	668^{de}	32.4^{e}	10.2^{b-f}	104.0^{b-e}	6.67^{d-g}	38.3^{b-f}
T_1S_4	712^{d}	34.1^{cde}	10.2^{b-f}	105.0^{b-e}	7.02^{c-f}	39.3^{b-f}
T_1S_5	558^{f}	24.8^{g}	9.6^{efg}	94.0^{ghi}	5.70^{h}	32.6^{gh}

T_1S_6	538^{f}	23.0^{g}	9.7^{d-g}	93.5^{ghi}	5.73^{h}	33.5^{fgh}
T_1S_7	969^{b}	40.5^{b}	10.7^{ab}	110.0^{ab}	7.75^{b}	42.0^{ab}
T_1S_8	604^{ef}	27.6^{fg}	9.5^{fg}	89.5^{hi}	5.55^{h}	32.5^{gh}
T_1S_9	693^{d}	33.6^{cde}	9.9^{c-f}	96.0^{e-h}	6.65^{d-g}	34.9^{efg}
T_1S_{10}	428^{g}	11.7^{h}	9.0^{g}	85.5^{i}	5.5^{h}	25.9^{i}
T_2S_1	823^{c}	34.5^{cde}	10.4^{bcd}	102.0^{b-g}	6.90^{c-f}	39.5^{b-e}
T_2S_2	841^{c}	37.3^{bcd}	10.4^{bcd}	105.0^{b-e}	6.95^{c-f}	40.0^{a-e}
T_2S_3	814^{c}	32.6^{de}	10.4^{bcd}	107.0^{bcd}	7.13^{b-e}	40.2^{a-d}
T_2S_4	853^{c}	38.2^{bc}	10.6^{abc}	108.0^{bcd}	7.52^{bc}	42.2^{ab}
T_2S_5	714^{d}	30.5^{ef}	9.9^{c-f}	98.0^{d-h}	6.55^{efg}	35.4^{d-g}
T_2S_6	691^{d}	27.2^{fg}	10.0^{b-f}	99.5^{c-g}	6.62^{d-g}	35.2^{d-g}
T_2S_7	1131^{a}	45.7^{a}	11.2^{a}	118.0^{a}	8.87^{a}	44.7^{a}
T_2S_8	724^{d}	27.2^{fg}	10.2^{b-f}	94.5^{f-i}	6.52^{efg}	36.9^{c-g}
T_2S_9	822^{c}	37.4^{bcd}	10.3^{b-e}	103.5^{b-f}	7.25^{bcd}	40.8^{abc}
T_2S_{10}	532^{f}	13.0^{h}	9.5^{fg}	89.5^{hi}	6.02^{gh}	29.1^{hi}
S.Em.±	28.2	1.50	0.24	2.86	0.20	1.56
C.D at 5%	79.5	4.23	0.66	8.06	0.57	4.39

* 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.±	1.9	0.004	449.3
C.D at5%	5.3	0.012	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.± C.D at 5%	6.0 16.9	0.01 0.04	1421 4006

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.± C.D at5%	0.17 0.49	1.70 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.± C.D at 5%	0.39 1.10	3.79 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
	9.0	13.1

Table 4: Gross returns, net returns and B:C ratio as influenced by nitrogen substitution through organics and use of biorational and plant extract sprays (Pooled data of 2009 and 2010)

Treatments	Gross returns	Net returns	B:C ratio
Sources of nitrogen			
T_1:100:50:50 kg NPK ha^{-1} (RDF)*	32700^{b}	18670^{b}	2.09 ^{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**	39730^{a}	20900^{a}	2.31 ^{a}
S.Em.±	446	442	0.03
C.D at5%	1257	1268	0.08
Biopesticides sprays			
S_1: Nimbecidine – GCK	37490^{b}	21540^{b}	2.37 ^{b}
S_2: Nimbecidine – Leaf extract	38400^{b}	22470^{b}	2.40 ^{b}
S_3: Nimbecidine - Panchagavya	37040^{b}	20520^{b}	2.26 ^{b}
S_4: Nimbecidine – Leaf extract +Panchagavya mixture spray	39100^{b}	22800^{b}	2.42 ^{b}
S_5: Nimbecidine - Silica spray	31810^{c}	15310^{c}	1.93 ^{c}
S_6: Nimbecidine - Action 100 spray	30700^{c}	14610^{c}	1.91 ^{c}
S_7: Abamectin (1.9 EC) - Perfect	52480^{a}	32510^{a}	2.64 ^{a}
S_8: Silica	32270^{c}	17100^{c}	2.06 ^{c}
S_9: RPP	37880^{b}	21410^{b}	2.32 ^{b}
S_{10}: Control	23980^{d}	9580^{d}	1.68 ^{d}
S.Em.±	997	989	0.06
C.D at 5%	2811	2787	0.17
Interaction			
T_1S_1	33800de	20280^{b-e}	2.24 ^{def}
T_1S_2	34750^{d}	21050^{bcd}	2.27 ^{cde}
T_1S_3	33410de	19310^{b-e}	2.16 $^{e-h}$
T_1S_4	35580^{d}	21680^{bc}	2.28 $^{b-e}$
T_1S_5	27920^{f}	13820^{fgh}	1.89 ^{hi}
T_1S_6	26900^{f}	13140^{ghi}	1.87 ^{i}
T_1S_7	48440^{b}	30890^{a}	2.52 $^{a-d}$
T_1S_8	30210^{ef}	16580^{d-g}	1.94 ^{ghi}
T_1S_9	34660^{d}	20590^{b-e}	2.18 ^{efg}
T_1S_{10}	21360^{g}	9360^{i}	1.59 ^{j}
T_2S_1	41150^{c}	22800^{b}	2.50 $^{a-d}$
T_2S_2	42050^{c}	23890^{b}	2.54 ^{abc}
T_2S_3	40680^{c}	21730^{bc}	2.37 $^{b-e}$
T_2S_4	42630^{c}	23930^{b}	2.56 ^{ab}
T_2S_5	35700^{d}	16800^{d-g}	1.98 ^{ghi}
T_2S_6	34530^{d}	16080^{efg}	1.96 ^{ghi}
T_2S_7	56530^{a}	34130^{a}	2.75 ^{a}

T_2S_8	36330[d]	17630[c-f]	2.17 [efg]
T_2S_9	41100[c]	22230[b]	2.46 [bcd]
T_2S_{10}	26600[f]	9800[hi]	1.78 [ij]
S.Em.±	1410	1398	0.09
C.D at 5%	3975	3941	0.24

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