Effect of Integrated Nitrogen Management Treatments on Growth Yield and economics of Soybean [*Glycine max* (L.) Merrill]

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ABSTRACT

Soybean, being an important pulse as well as oil seed needs special mention to overcome crisis in edible oil production in the country. It is also called as "Gold of soil". An experiment was conducted at College of Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand (Gujarat) during *kharif* (Soybean) and *rabi* (Amaranthus) season of the years 2019-20 and 2020-21. An agronomical investigation entitles effect of integrated nitrogen management in soybean and their residual effect on grain amaranthus under irrigated condition. The experiment soil was medium in organic carbon (0.40%), available phosphorus (36.20 kg/ha) and available potassium (209 kg/ha) with soil pH (8.15). There were ten integrated nutrient management treatments arranged in Randomized block design with four replications. Integrated used of the organic and inorganic sources of plant nutrients on growth and yield attributes is very crucial for the assurance of food securities. Different observation on the crop parameters were carried out during course of investigation. Integrated nitrogen managements did not exert any significant response on plant population recorded at 20 DAS and at harvest and plant height at 30 DAS. All growth and yield parameters *viz*., plant height at 60 DAS, plant height at harvest, number of branches/plant, root nodules/plant, dry weight of root nodules, seed yield and straw yield were recorded significantly higher with the application of 50% RDN through vermicompost + 50% RDN through inorganic fertilizer (T_3) sustainable agricultural productivity might be due to achieved through wise used of integrated nutrient management.

Key words Soybean, Nitrogen, Vermicompost, FYM,

INTRODUCTION:

Soybean is finding its place in policy agenda of industrial, medicinal and food sector on India due to wide spectrum of its chemical composition (Awasrmal *et.al*., 2013). The dry seed having reach source of all mineral nutrition, so soybean often designated as golden bean is an important pulse as well as oil seed crop of the world being a legume plant with help of root nodule bacteria and to add organic matter in soil (Dipak *et.al.*,2018). Soybean is considered as a wonder crop due to its dual duality.

The integrated nutrient management plays the way to overcome the problems which involved conjunctive used of chemical fertilizers, organic manures and biofertilizers to crop production and maintain soil health (Sharma *et.al*.,2018). Integrated nutrient management has been proposed as a promising strategy for addressing such challenges, it has multifaceted potential for the improvement of plant performance and resource efficiency while also enabling the environment and resource quality. It may include organic manures i.e. vermicompost, Farm yard manure, green manure and other resource for sustainable agriculture (Verma *et.al.,* 2017). The organic manures along with biofertilizer help in reducing the dose of inorganic fertilizer, which in turn reduced the cost of cultivation and help to improve the soil health. (Verma *et.al.*, 2017). Efficient management of organic and inorganic source is prerequisite. For achieving continuous production of crops in an economically and sustainable manner. Organic matter forms a very important source of plant nutrients whereas organic manures are used to supply both macro and micronutrients and sustain amount of humic substances particularly humic and fulvic acid that helps to maintain soil pH. Thus, for maintenance of the soil fertility, productivity and soil health with the FYM, compost and biofertilizers can't replace chemical fertilizers but certainly are capable of reducing their inputs (Dipak *et.al.*,2018).

Appropriate and conjunctive used of application of suitable nutrients through organic and inorganic solely or in combination can provided the solutions to the problem such as increase price of inorganic fertilizers and deterioration effect of soil fertility and productivity (Singh and Kushwaha, 2018). Integrated use of nutrient is very essential approach, which not only sustains high crop production over the years but also improves soil health and ensures a safer environment.

MATERIALS AND METHODS

A field experiment was conducted at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand, (Gujarat) during *kharif* (Soybean) and *rabi* (Amaranthus) season of the years 2019-20 and 2020-21. The soil of experimental field was loamy sand in texture having good drainage. The pH (8.15) was alkaline and low in soluble salts. The experimental site was deficient in organic carbon (0.40 %), low available nitrogen (200 kg/ha), medium in available phosphorus (36.20 kg/ha) and available potassium (209 kg/ha). The experiment was laid out in Randomized Block Design with four replications. The ten integrated nitrogen management treatments *viz.*, $\mathbf{T_1}$: RDN (45 kg/ha) through inorganic fertilizer, $\mathbf{T_2}$ 50% RDN through FYM + 50% RDN through inorganic fertilizer, $\mathbf{T_3}$:50% RDN through vermicompost + 50% RDN through inorganic fertilizer $\mathbf{T_4}$: 50% RDN through castor cake + 50% RDN through inorganic fertilizer, $\mathbf{T_5}$: Bio NP (*Rhizobium* + PSB) + 50% RDN through inorganic fertilizer, $\mathbf{T_6}$: 25% RDN through FYM + 75% RDN through inorganic fertilizer $\mathbf{T_7}$: 25% RDN through vermicompost + 75% RDN through inorganic fertilizer $\mathbf{T_{8:}}$ 25% RDN through castor cake + 75% RDN through inorganic fertilizer $\mathbf{T_9}$: Bio NP (*Rhizobium* + PSB) + 75% RDN through inorganic fertilizer $\mathbf{T_{10}}$:25% RDN through FYM + Bio NP (*Rhizobium* + PSB) seed treatment + Soil drenching at 20 DAS were studied. Soybean variety NRC 37 was used for experiment. All recommended fertilizer was applied at time of sowing. Nitrogen was applied through urea and phosphorus through single super phosphate. Five plants from each net plot were selected and used for the recording biometric observations at importance critical growth stages. The statistical analysis was carried out on pooled basis. Nitrogen and phosphorus through urea and single super phosphate. Application of well decomposed farm yard manure, vermicompost and castor cake were applied as per treatment before 15 days of sowing.

RESULTS AND DISCUSSION

EFFECT OF INTEGRATED NITROGEN MANAGEMENT ON SOYBEAN

Plant population at 20 DAS and harvest did not showed significant response of treatments. Periodical plant height at 30, 60 DAS and harvest significantly effect by various integrated nutrient management treatment. Application of 50% RDN through vermicompost + 50% RDN through inorganic fertilizer (T_3) reports significantly higher plant height at 60 DAS (62.13 cm) and at harvest (80.38 cm) compared to rest of treatments except treatment T_2 (50% RDN through FYM + 50% RDN through inorganic fertilizer) at 60 DAS and T_2 (50% RDN through FYM + 50% RDN through inorganic fertilizer), T_1 (RDN 45 kg/ha through inorganic fertilizer) and T_4 (50% RDN through castor cake + 50% RDN through inorganic fertilizer) at harvest (Table 1). It might be due to that increase in the plant height with application of 50% RDN through vermicompost + 50% RDN through inorganic fertilizer is quite obvious due to supply of macro as well as micro nutrients through organic source, which improve soil physical and biological properties and increase the availability of nutrients and solubilizing them. Thus, favourable influence of nutrients to produce larger cells with thinner cell walls and its contribution in cell division and cell elongation which improved vegetative growth and ultimately increased the plant height of soybean. These are in conformity with the results of Konthoujam *et al.* (2013), Khare *et al.* (2016), Patil *et al.* (2016) and Sharma (2018).

Data presented in Table-1 revealed that application of 50% RDN through vermicompost + 50% RDN through inorganic fertilizer (T_3) reported significantly higher number of branches per plant (4.48) but it did not differ significantly treatment 50% RDN through FYM + 50% RDN through inorganic fertilizer (T_2). The probable reason behind that application of vermicompost was probably due to cytokine synthesis and rapid conversion of synthesized carbohydrates into protein, consequent to increase in the number and size of growing cells, resulting ultimately into more number of branches. These results are in agreement with those obtained by Machhar *et al.* (2016) Khare *et al.* (2016) and Verma *et al.* (2017).

Data on root nodules/plant (39.73) and dry weight of nodule (123.78 mg) showed higher root nodules/plant and dry weight of nodules (Table 1) was observed in treatment T_3 (50% RDN through vermicompost + 50% RDN through inorganic fertilizer) which was applied to soybean crop but which was found at par with the treatment 50% RDN through FYM + 50% RDN through inorganic fertilizer (T_2). It can be attributed to the fact that nitrogen and phosphorus supply from chemical and organic resources had stimulating effect on nodulation through developing effective nodules and moreover, nodule leghaemoglobin content might have added more root nodules plant^{-1}. These results are in conformity with the reports of Patil *et al.* (2016), Ghodke *et al.* (2018) and Chaudhari (2019). Second reason might be due to availability of abundant organic matter and effective microbial activities because of sufficient supply of feeding materials for Rhizobium bacteria in the form of humus (Dhakale *et.al*.,2016 and Chaudhary *et.al.*,2019). The maximum number of nodules per plant may be due to favourable effects of FYM in improving the soil fertility through positive effects on physical, chemical and biological soil properties.

Number of pods/plant (55.25) and seed index (9.68 g) was higher in treatment T_3 (50% RDN through vermicompost + 50% RDN through inorganic fertilizer) than rest treatments except treatment T_2 (50% RDN through FYM + 50% RDN through inorganic fertilizer) and (T_2**)** 50% RDN through FYM + 50% RDN through inorganic fertilizer in number of pods/plant. While in case of seed index treatment T_3 was statically par with treatment T_1 (RDN (45 kg/ha) through inorganic fertilizer), T_2 50% RDN through FYM + 50% RDN through inorganic fertilizer, T_4 (50% RDN through castor cake + 50% RDN through inorganic fertilizer, T_6 (25% RDN through FYM + 75% RDN through inorganic fertilizer) and T_7 (25% RDN through vermicompost + 75% RDN through inorganic fertilizer). Application of organic manure /Vermicompost application through delayed leaf senescence and this might be the reason for increased seed weight. Secondly, better growth and development of crop plants due to nitrogen supply might have increased the supply of assimilates to seed, which ultimately gained more weight. This was perhaps due to a continuous supply of nitrogen to the crop at the early stages and through organic manure at later stages of crop growth, as slow-release nutrients might have increase grain weight (Rana *et al.*,2016 and Verma *et al.*, 2017).

The results of the data revealed that seed yield and stover yield of soybean significantly escalated with integrated nutrient management treatments (Table 1 and Fig.1). Application of 50% RDN through vermicompost + 50% RDN through inorganic fertilizer (T_3) reported higher seed (2205 kg/ha) and stover yield (2811 kg/ha). Treatment T_3 did not differed significantly with treatments T_1 (RDN 45 kg/ha through inorganic fertilizer), T_2 (50% RDN through FYM + 50% RDN through inorganic fertilizer) and T_4 (50% RDN through castor cake + 50% RDN through inorganic fertilizer) in seed yield while in case of stover yield treatment T_3 was closely related to treatments T_2 (50% RDN through FYM + 50% RDN through inorganic fertilizer) and T_4 (50% RDN through castor cake + 50% RDN through inorganic fertilizer). The seed yield was higher with application of 50% RDN through vermicompost + 50% RDN through inorganic fertilizer due to the higher availability of nutrients as well as amino acids, vitamins and growth promoting substance throughout the crop growth; it led to the increased number of pods/plant resulting in higher seed yield. Other reason might be due to increasing yield might be due to the increased growth and yield attributes *i.e.,* plant height and number of branches/plant resulting in favourable environment for vegetatively as well as reproductively crop growth from initial growth stage to harvest, thus enabling the crop for maximum utilization of nutrients, moisture, light, and space which consequently caused significant increase in photosynthesis and dry matter accumulation, which resulted in higher stover yield of soybean. It also might be due efficient and greater partitioning of metabolites and adequate location of nutrients to develop plant structure. Organic manure as a source of organic matter is also known to favourable improve soil structure, increase water holding capacity and providing energy for nitrogen fixing by free living heterotrophic microorganism thus make increased in various yield components can be ascribed not only to adequate supply of assimilates/nutrients but also to their pivotal role in improving soil thereby enhancing root growth. Above all, the role of balanced fertilizer is the application of essential plant nutrients in right proportion and in optimum quantity for a specific soil crop condition in alleviating the yield, quality, and its attributes (Maruthi *et al.*,2014, Rana and Badiyala, 2014, Machhar *et al.*, 2016 and Verma *et al.*, 2017).

Integrated used of fertilizer on soybean reported significantly on quality parameter like oil content and protein content. Integrated nutrient management practices significantly affected oil and protein content (Table 2 and Fig 1). Application of 50% RDN through vermicompost + 50% RDN through inorganic fertilizer (T_3) reported significantly higher oil content (20.69 %) and protein content (40.26 %). It might be due that nitrogen from inorganic fertilizers was available to the crop at early stages and through organic manures at later stages of the crop growth, due to slow-release nitrogen. Then, resulting later stage nitrogen availability through increased protein content. Bacchav and Sable (1996) recorded that application of nitrogen in the form of urea and FYM significantly influenced the protein content of soybean over control. The present findings are in close accordance with the findings of Konthoujam *et al.* (2013), Rana and Badiyala (2014), Patil *et al.* (2016) and Chaudhari *et.al.* (2019).

Soil microbial count (135.35 × 10^{-7} CFU g^{-1}) was higher in T_{10} (25% RDN through FYM + Bio NP (*Rhizobium* + PSB) seed treatment + Soil drenching at 20 DAS) than other treatment. Increasing higher microbial count might be due to availability of abundant organic matter and effective microbial activities because of sufficient supply of feeding material for *Rhizobium* bacteria in the form of humus. Other reason might be due to soil microbial community, most of the soil bacteria are heterotrophic in nature depending on the C supply, energy and nutrient supply and in 50% organic + 50% inorganic and 100% organic treatments, the effect of added organic matter in soil provided the energy as well as carbon to the bacterial population for their cell component synthesis resulting in higher bacterial population. The results corroborated with the findings of Kibunja *et al.* (2010) who stated that treatments with farmyard manure supported higher number and activity of various groups of microorganisms probably due to higher SOC content. Chemical fertilizers alone on the other hand did not enhance SOC build up but instead raised the soil pH, which probably explains the low numbers recovered from the treatments with chemical fertilizers.

ECONOMICS

Different in economics were significant due to various treatments. The data presented in Table-2 & Fig 02 revealed application of 50% RDN through FYM + 50% RDN through inorganic fertilizer (T_2) accrued maximum net realization (₹ 57815/ha) followed by treatment T_1 [RDN (45 kg/ha) through inorganic fertilizer] with net realization of (₹ 57031/ha). The lowest net realization of (₹ 42042/ha) was noticed with treatment T_5 [Bio NP (*Rhizobium* + PSB) + 50% RDN through inorganic fertilizer]. The highest benefit cost ratio of 3.23 was recorded under application of RDN (45 kg/ha) through inorganic fertilizer (T_1) followed by T_9 (Bio NP (*Rhizobium* + PSB) + 75% RDN through inorganic fertilizer) (2.92). Application of 25% RDN through FYM + Bio NP (*Rhizobium* + PSB) seed treatment + Soil drenching at 20 DAS (T_{10}) registered the lowest benefit cost ratio of 2.57 as compared to other treatments.

CONCLUSIONS

It can be concluded that integrated use of organic and inorganic source significantly enhanced growth, yield attributes, yield of soybean as well quality parameter, soil microbial population and economics of soybean. Therefore, integrated use of 50% organic and + 50% inorganic source of nutrient was found best for most of the symbiotic, plant growth and yield parameters of soybean. Therefore, proper nutrient management practices improve overall quality of soybean soil which will help to maintain the sustainability of the production.

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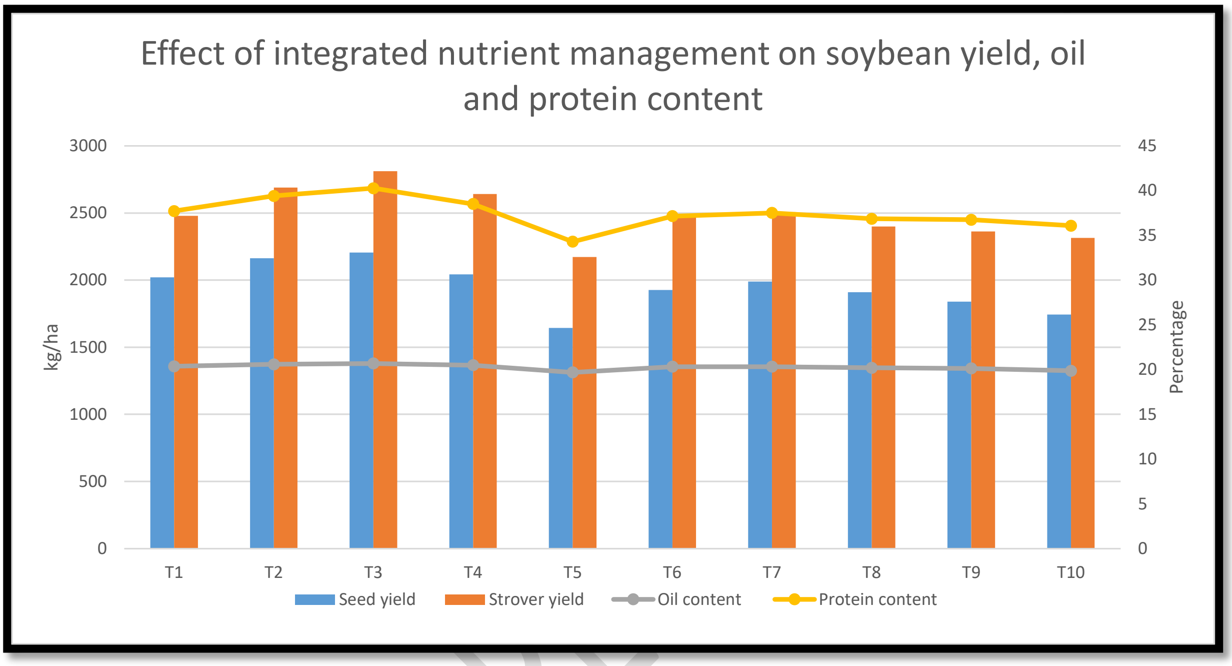

Fig. 01 Effect of treatments on yield, oil and protein content of soybean

Fig. 02 Effect of treatments on economics of soybean

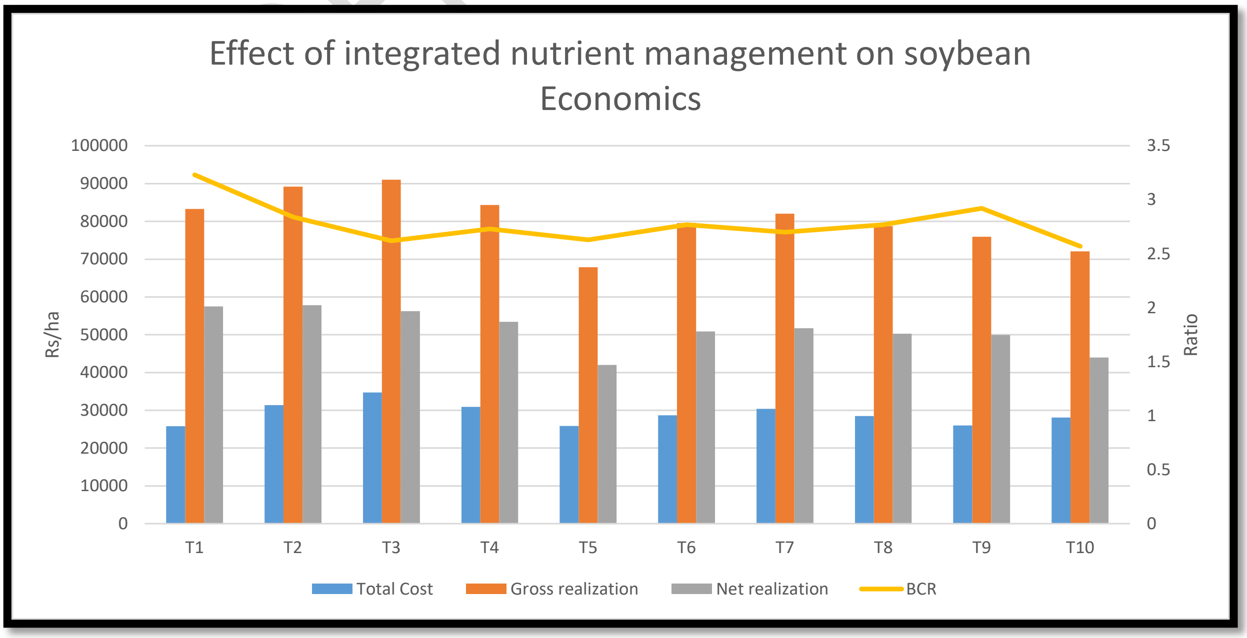

Table 1. Plant population at 20 DAS, Plant population at harvest, plant height at 30 DAS, 60 DAS and harvest as influenced by integrated nitrogen management treatments

(Pooled of two year)

Treatment		**Plant stand**		**Plant height (cm)**			**Branches/ plant**	**Root nodules /plant**	**Dry weight of root nodules (mg)**	**Seed yield (kg/ha)**	**Stover yield (kg/ha)**
		20 DAS	**Harvest**	**30 DAS**	**60 DAS**	**Harvest**					
T_1		9.28	8.63	30.95	58.05	76.17	4.17	35.39	120.60	2021	2479
T_2		9.35	8.84	31.43	60.57	80.17	4.36	38.58	122.33	2162	2690
T_3		9.44	8.88	32.41	62.13	80.38	4.48	39.73	123.78	2205	2811
T_4		9.31	8.78	31.11	56.68	78.06	4.25	37.49	121.41	2043	2642
T_5		9.01	8.22	28.10	52.25	68.27	3.90	32.80	116.72	1643	2172
T_6		9.22	8.58	30.18	55.41	75.12	4.15	35.28	118.98	1926	2484
T_7		9.22	8.62	30.28	57.27	75.21	4.18	35.27	119.76	1989	2507
T_8		9.15	8.53	29.53	55.43	75.21	4.11	34.92	118.11	1909	2399
T_9		9.13	8.39	29.38	54.87	74.32	4.02	34.49	118.25	1839	2363
T_{10}		9.10	8.36	28.93	54.42	72.07	3.96	33.75	117.85	1744	2315
S.Em. ±	Y	0.04	0.07	0.37	0.40	0.76	0.03	0.35	0.39	29	37
	T	0.10	0.17	0.78	0.89	1.72	0.07	0.75	0.83	65	79
	Y ×T	0.14	0.24	1.19	1.28	2.43	0.11	1.13	1.26	92	119
C. D. at 5 %	Y	NS	NS	NS	1.15	NS	NS	NS	NS	NS	NS
	T	NS	NS	NS	2.58	4.87	0.20	2.14	2.36	184	239
	Y ×T	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	CV %	3.06	5.79	7.91	5.79	7.91	5.34	6.35	2.11	9.46	9.56

Table 2. Quality parameters and economics of soyabean as influenced by integrated nitrogen management treatments **(Pooled of two year)**

Treatment		Harvest Index (%)	Number of pods/plant	Number of seeds/pod	Seed index (g)	Oil content (%)	Protein content (%)	Soil microbial count (× 10^{-7} CFU g^{-1})	Total cost of cultivation (₹/ ha)	Gross realization (₹/ha)	Net realization (₹/ha	BCR
T_1		44.99	52.47	2.93	9.31	20.37	37.72	116.60	25826	83319	57493	3.23
T_2		44.50	54.34	2.98	9.65	20.59	39.40	129.64	31355	89170	57815	2.84
T_3		43.80	55.25	3.10	9.68	20.69	40.26	128.95	34730	91011	56281	2.62
T_4		43.60	53.64	2.95	9.45	20.49	38.50	126.85	30943	84362	53419	2.73
T_5		43.40	49.13	2.55	8.58	19.69	34.29	132.48	25850	67892	42042	2.63
T_6		43.69	51.00	2.80	9.35	20.33	37.15	127.82	28679	79524	50845	2.77
T_7		44.34	52.08	2.86	9.32	20.32	37.51	128.60	30367	82067	51700	2.70
T_8		44.39	50.12	2.78	9.13	20.20	36.86	126.43	28473	78759	50286	2.77
T_9		43.81	50.02	2.72	8.85	20.13	36.74	134.33	25987	75923	49936	2.92
T_{10}		43.07	49.51	2.71	8.73	19.87	36.08	135.35	28068	72075	44007	2.57
S.Em. ±	Y	0.44	0.41	0.06	0.07	0.05	0.33	0.98	-	-	-	-
	T	1.00	0.86	0.13	0.16	0.12	0.70	2.09	-	-	-	-
	Y ×T	1.42	1.30	0.19	0.23	0.17	1.04	3.10	-	-	-	-
C. D. at 5 %	Y	NS	NS	NS	NS	NS	NS	NS	-	-	-	-
	T	NS	2.45	NS	0.47	0.33	1.96	5.91	-	-	-	-
	Y ×T	NS	NS	NS	NS	NS	NS	NS	-	-	-	-
	CV %	6.46	5.05	14.01	5.11	1.74	5.59	4.82	-	-	-	-