

Original Research Article

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Effect of Integrated Nitrogen Management on Macronutrient Content in Toria (*Brassica campestris* L.var.M-27)

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Field experiments were conducted to study the effect of integrated nitrogen management on macronutrient content in Toria (*Brassica campestris* L.var. M-27) during the Rabi seasons of 2015-16 and 2016-17. Urea, Vermicompost, and *Azolla* were applied as nitrogen sources including one untreated control. *Azotobacter* also inoculated along with the seed. Results revealed that application of integrated nitrogen management improved the N, P and K content of toria in both the years of study as well as pooled data. A declining trend of N, P and K content in toria with crop age was recorded which might be due to dilution effect, caused by higher dry matter production, low nutrient status of soil and fixation of applied nutrient. Statistically higher macro-nutrient concentration in toria was observed in soil treated with 75% RDN using Urea + 25% RDN using Vermicompost which is at par with 50% RDN using Urea + 50% RDN using Vermicompost, 100% RDN using chemical fertilizer Urea + 100% RDN using Vermicompost + 100% using *Azolla* + *Azotobacter* and 100% RDN using chemical fertilizer Urea. This might be due to release of nutrients from organic sources thereby increasing soil availability along with inorganic source during the growing stage.

Introduction

Among the oilseeds, rapeseed (*Brassica campestris* L. var. M-27) is one of the important oilseed crops grown in Rabi season contributing 25 % of the oilseed production of the country (Chidha Singh, 1983). India holds a premier position in rapeseed – mustard economy of the world with third rank in both area and production (Rai *et al.*, 2016). Important of oilseeds, as a source of both fat and protein is well known. The oil content of rapeseed- mustard seed ranges from 30-47 %

and 20 – 40% protein. It accounts for 19 % of world's area and 9 % of the global production (Sinha, 2003). In Manipur, rapeseed occupies an area of 37.67 thousand ha with an annual production of 32.78 thousand Mt and productivity of 0.87 Mt ha⁻¹ (Anonymous, 2017-18). Rapeseed is grown entirely as a rainfed crop due to non – availability of irrigation facilities in Manipur. Enhancement of the productivity of rapeseed – mustard can be achieved by the use of balanced fertilization by application of nitrogen through organic and inorganic manures is of

great significance, so as to attain maximum economic yield without any deleterious effect on soil properties or ecological balance.

Analysis of plant sample is an important component of soil fertility evaluation and plant nutrition research. It has been used as a diagnostic technique for assessing deficiency and toxicity of nutrients in plants. It is also used for determining the nutrient status and fertilizer needs. Maintenance of soil fertility for sustainable production requires replenishment of nutrient elements removed by crops through application of fertilizer. Balanced use of nutrients is one of the most important factor for sustaining rice production and soil health.

The results emanating from long-term fertilizer experiments have clearly indicated that imbalance use of chemical fertilizers has resulted in numerous problems *viz.* micronutrient deficiencies, nutrient imbalances in soil and plant system, depletion of soil fertility, environmental degradation and deterioration of soil health (Kimmo, 1993). A fertile soil will contain all the major nutrients for basic plant nutrition (N, P and K) as well as other nutrients needed in smaller quantities (Ca, Mg, S, Fe, Zn, Cu, B, Mn, etc.). Usually, a fertile soil will also have some organic matter that improves soil structure, soil moisture retention, nutrient retention and a pH of 6 - 7. Unfortunately, soils that do not have adequate levels of all the necessary plant nutrients, or conditions in the soil are unfavourable for plant uptake of certain nutrients. It is; therefore, appropriate to develop a sustainable crop production technology which is cheaper, locally available, socially acceptable and environmentally sound *vis-à-vis* maintains soil health. Such a scenario can be retrieved through integration of chemical fertilizers with available organic sources of plant nutrients. Integrated nutrient management

(INM) aims to improve soil health and sustain high level of productivity and production (Prasad *et al.*, 1995) Latha *et al.*, (2019) reported increased in N, P and K contents in toria with the application of organics as well as inorganic fertilizers. Organics supply nutrients at the peak period of absorption, and also provide micro nutrients and modify soil-physical behaviour as well as increase the efficiency of applied nutrients (Pandey *et al.*, 2007). Keeping this in view, an investigation was undertaken to study the effect of integrated nutrient management on macronutrient content in toria.

Materials and Methods

A field experiment was undertaken at Research Farm of College of Agriculture, Central Agricultural University, Imphal during two consecutive years of 2015-16 and 2016-17. The experimental site was situated at 24°48'44.50" N latitude, 93°53'29.98" E longitude and altitude of 790m above mean sea level. It comes under the Eastern Himalayan Region (II) and the agro-climatic zone Sub-Tropical Zone (NEH-4) of Manipur (Experimental Agro met Advisory Service ICAR Complex for NEH Region, Manipur Centre, Lamphelphet, Imphal). Imphal valley enjoys sub-tropical climate with an average annual rainfall of about 1467.5 mm. Monsoon rain start from the month of June and continues up to October with pre-monsoon showers from March onward. During the experimentation periods, the mean maximum and minimum temperatures lies between 27.8°C and 4.6°C.

The relevant physicochemical properties of the soil were presented in Table 1. Soil texture, water holding capacity (WHC), pH, EC, organic carbon, cation exchange capacity (CEC), available N, P and K were determined following the standard procedure described by Jackson (1973). The experiment was laid out

in Randomised Block Design with twelve treatments replicated thrice. The treatments were applied to rapeseed (Toriavar.M-27).

The treatments used in the study were T₀-control, T₁- 100% RDN using chemical fertilizer Urea, T₂-100% using Vermicompost as N-source, T₃- 100% using *Azolla* as N-source + *Azotobacter*, T₄-75% RDN using Urea + 25% RDN using Vermicompost, T₅-75% RDN using (Urea) + 25% using *Azolla* + *Azotobacter*, T₆-50% RDN using Urea + 50% RDN using Vermicompost, T₇-50% RDN using Urea + 50% using *Azolla* + *Azotobacter*, T₈-25% RDN using Urea + 75% RDN using Vermicompost, T₉-25% RDN using Urea + 75% using *Azolla* + *Azotobacter*, T₁₀-100% RDN using Vermicompost + 100% using *Azolla* + *Azotobacter*, T₁₁- 100% RDN using chemical fertilizer + 100% RDN using Vermicompost + 100% using *Azolla*+ *Azotobacter*.

Application of fertilizer was made as per treatment. The recommended dose of fertilizer for toria was 40:30:20 kg N, P₂O₅ and K₂O per ha respectively. Full dose of phosphorus (P₂O₅), potassium (K₂O) and half dose of nitrogen (N) as urea were applied as basal application a day before the date of sowing in the form of urea, single super phosphate (SSP) and muriate of potash (MOP), respectively. The vermicompost was thoroughly mixed in soil as per treatment after final ploughing. The remaining dose of nitrogen was top dressed at pre-flowering stage. *Azolla* was collected from the surrounding area and made dried in shade. In the meantime, dried *Azolla* @ 1.16 tonnes ha⁻¹, 0.87 tonnes ha⁻¹, 0.58 tonnes ha⁻¹ and 0.29 tonnes ha⁻¹ equivalent to 40 kg N ha⁻¹ (100% RDN), 30 kg N ha⁻¹ (75% RDN), 20 kg N ha⁻¹ (50% RDN) and 10 kg N ha⁻¹ (25% RDN) were applied according to different sets of treatment. Again, properly clean seeds were used for seed treatment in rapeseed. Gur

slurry was prepared and poured on seed. *Azotobacter* @ 20 g kg⁻¹ seeds was added and mixed by hand till the seeds were uniformly coated except control. The treated seeds were dried in shade and sown immediately.

Plant samples were periodically collected randomly at 30th, 60th, and 90th days after sowing (DAS) and at the time of harvest. Samples were washed properly, then, dried at 65°C for 72 hours, powdered and kept for analysis of macronutrient (N, P and K) content. Total N content was estimated using the modified micro kjeldahl method as described by Jackson (1973). Di-acid (HNO₃: HClO₄) extracts of plant samples were subjected to analysis of P using the vanadomolybdate phosphoric acid yellow colour (Ammonium molybdate + ammonium metavanadate) method and total potassium was determined flame photometrically from the same extract Jackson (1973).

Results and Discussion

Nitrogen (N) content

Data on effect of nitrogen content in toria at different growth stages are shown in Table 2. Result revealed that N content in both the years of the experiment followed similar patterns. An increase in N content was noticed at 60th DAS followed by a decreasing trend till the harvest stage. However, in the second year higher N content was observed in all the sampling days as compared to first year. Irrespective of different crop growth, significantly higher N concentration was observed in both the years over the control. Pooled data also showed the same trend of nitrogen accumulation at different stages. Irrespective of different sampling days and year of the study, application of inorganic or organic sources of nitrogen either singly or in combination significantly increased the nitrogen concentration in crop over untreated

control. This is corroborated with the findings of Nehra and Grewal (2001); Jana *et al.*, (2008); Sharif *et al.*, (2004); Sarir *et al.*, (2005); Davari *et al.*, (2012); Bairwa and Yadav (2017).and Nongmeikapam and Devi (2018). Further study of the pooled data

revealed that concentration of N in soil applied with T₄, T₆, T₇, T₈, T₉, T₁₁, respectively were at par at different stages of crop growth. However, on 60th DAS soil treated with different N treatments observed non-significantly difference among them.

Table.1 Initial soil characteristics of the experimental field

Soil characteristics	Results
Textural class	Clayey soil
Sand (%)	8.24
Silt (%)	13.44
Clay (%)	78.32
pH (1:2.5 soil : water ratio)	5.40
EC (1:2.5 soil : water ratio, dsm ⁻¹)	0.28
CEC [cmol(p ⁺)kg ⁻¹]	34.05
Organic carbon (%)	1.56
Available Nitrogen (Kg N ha ⁻¹)	389.39
Available Phosphorus (Kg P ₂ O ₅ ha ⁻¹)	57.71
Available potassium (Kg K ₂ O ha ⁻¹)	252.67

Table.2 Effect of integrated nitrogen management on N content (%) at different stages of toria

Treatments	30 DAS			60DAS			90DAS			At harvest		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
T ₀	0.98	1.08	1.03	1.04	1.10	1.07	0.94	0.95	0.94	0.80	0.87	0.84
T ₁	1.15	1.38	1.27	1.17	1.41	1.29	1.03	1.15	1.09	0.89	0.98	0.94
T ₂	1.11	1.35	1.23	1.16	1.36	1.26	1.03	1.14	1.09	0.89	0.99	0.94
T ₃	1.09	1.34	1.21	1.15	1.35	1.25	1.02	1.09	1.06	0.89	0.98	0.93
T ₄	1.15	1.39	1.27	1.17	1.45	1.31	1.04	1.18	1.11	0.92	0.99	0.96
T ₅	1.14	1.37	1.26	1.16	1.43	1.30	1.04	1.17	1.10	0.91	0.98	0.95
T ₆	1.15	1.38	1.27	1.17	1.44	1.30	1.04	1.18	1.11	0.91	0.98	0.95
T ₇	1.14	1.35	1.24	1.16	1.40	1.28	1.04	1.15	1.09	0.90	0.99	0.94
T ₈	1.17	1.41	1.29	1.19	1.48	1.33	1.06	1.20	1.13	0.93	0.99	0.96
T ₉	1.12	1.38	1.25	1.17	1.43	1.30	1.04	1.17	1.11	0.91	0.99	0.95
T ₁₀	1.11	1.35	1.23	1.16	1.40	1.28	1.03	1.15	1.09	0.90	0.98	0.94
T ₁₁	1.16	1.40	1.28	1.17	1.46	1.32	1.05	1.20	1.12	0.92	0.99	0.96
SE(d)±	0.022	0.027	0.029	0.023	0.027	0.046	0.020	0.022	0.026	0.018	0.019	0.012
CD(p=0.5)	0.046	0.055	0.064	0.048	0.057	0.101	0.042	0.047	0.058	0.037	0.040	0.024

Table.3 Effect of integrated nitrogen management on P content (%) at different stages of toria

Treatments	30 DAS			60DAS			90DAS			At harvest		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
T ₀	0.350	0.390	0.370	0.330	0.373	0.352	0.323	0.350	0.337	0.290	0.310	0.300
T ₁	0.410	0.410	0.410	0.393	0.393	0.393	0.389	0.390	0.390	0.360	0.360	0.360
T ₂	0.410	0.420	0.415	0.395	0.403	0.399	0.393	0.385	0.389	0.370	0.370	0.370
T ₃	0.390	0.410	0.400	0.380	0.393	0.387	0.373	0.385	0.379	0.350	0.360	0.355
T ₄	0.430	0.430	0.430	0.410	0.413	0.412	0.405	0.400	0.403	0.380	0.380	0.380
T ₅	0.420	0.420	0.420	0.395	0.403	0.399	0.403	0.395	0.399	0.380	0.370	0.375
T ₆	0.420	0.430	0.425	0.405	0.413	0.409	0.403	0.405	0.404	0.380	0.370	0.375
T ₇	0.410	0.420	0.415	0.395	0.403	0.399	0.393	0.395	0.394	0.372	0.370	0.371
T ₈	0.440	0.430	0.435	0.423	0.413	0.418	0.420	0.410	0.415	0.400	0.390	0.395
T ₉	0.410	0.410	0.410	0.395	0.395	0.395	0.393	0.393	0.393	0.360	0.370	0.365
T ₁₀	0.410	0.420	0.415	0.395	0.403	0.399	0.393	0.390	0.392	0.380	0.360	0.370
T ₁₁	0.440	0.430	0.435	0.423	0.413	0.418	0.413	0.405	0.409	0.390	0.380	0.385
SE(d)±	0.008	0.009	0.010	0.008	0.008	0.010	0.007	0.008	0.006	0.007	0.007	0.008
CD(p=0.5)	0.017	0.019	0.021	0.016	0.017	0.021	0.015	0.016	0.012	0.015	0.016	0.017

Table.4 Effect of integrated nitrogen management on K content (%) at different stages of toria

Treatments	30 DAS			60DAS			90DAS			At harvest		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
T ₀	1.19	1.21	1.20	1.00	1.01	1.00	0.80	0.80	0.80	0.71	0.73	0.72
T ₁	1.31	1.44	1.38	1.08	1.18	1.13	0.86	0.90	0.88	0.80	0.85	0.83
T ₂	1.32	1.42	1.37	1.09	1.18	1.13	0.85	0.90	0.88	0.81	0.88	0.85
T ₃	1.30	1.43	1.37	1.07	1.16	1.11	0.85	0.90	0.87	0.80	0.86	0.83
T ₄	1.33	1.45	1.39	1.10	1.20	1.15	0.88	0.96	0.92	0.83	0.92	0.88
T ₅	1.31	1.44	1.38	1.08	1.15	1.11	0.86	0.93	0.89	0.81	0.89	0.85
T ₆	1.32	1.45	1.39	1.09	1.20	1.14	0.87	0.94	0.90	0.82	0.91	0.87
T ₇	1.32	1.44	1.38	1.08	1.18	1.13	0.86	0.91	0.89	0.81	0.87	0.84
T ₈	1.34	1.47	1.41	1.11	1.21	1.16	0.89	0.97	0.93	0.84	0.92	0.88
T ₉	1.31	1.45	1.38	1.07	1.17	1.12	0.87	0.91	0.89	0.80	0.86	0.83
T ₁₀	1.30	1.43	1.37	1.07	1.17	1.12	0.86	0.91	0.89	0.81	0.87	0.84
T ₁₁	1.33	1.46	1.40	1.10	1.20	1.15	0.88	0.97	0.92	0.83	0.92	0.88
SE(d)±	0.026	0.028	0.023	0.021	0.023	0.020	0.017	0.018	0.017	0.016	0.017	0.013
CD(p=0.5)	0.054	0.059	0.050	0.044	0.048	0.044	0.035	0.037	0.038	0.033	0.036	0.025

Phosphorus (P) content

Data in relation to phosphorus content in toria at different stages are presented in Table 3. Result revealed that a decreasing trend in P content was observed with increase in crop

age in both the years and pooled data. Reports on decline in P concentration with crop age were given by Liu and Zhu (1996) and Latha *et al.*, (2019). The decrease of P content with the advancement of crop age might be due to three reasons: dilution effect, caused by

higher dry matter production and fixation of native and applied phosphorus. Study of the pooled data revealed that significantly higher P content was recorded in inorganic and organic sources applied singly or in combination over untreated control. Similar findings on higher concentration of phosphorus in either inorganic or organic treated soil or both were presented earlier by Nehra and Grewal (2001); Chaudhary *et al.*, (2011); Davari *et al.*, (2012); Sultana *et al.*, (2015); Shinde *et al.*, (2017) and Latha *et al.* (2019). The increased phosphorus content might be due to gradual release of nutrients from organic sources thereby increasing soil nutrients along with inorganic source and made available during the growing season (Gautam *et al.*, 2013). Decline in P content with advancement of crop age was found in all the treatments. Comparing among the different treatments, statistically higher P content in mustard was observed in T₈ showing parity with T₁₁ and T₄ followed by T₅ which showed similarity with T₆ at harvest stage. However, detailed study showed that P concentration in T₁₁, T₈, T₆ and T₄ were at par on 30th, 60th and 90th DAS.

Potassium (K) content

Perusal of the data in Table 4 presented a progressive decline in K content with advancement of crop growth in toria was observed in both the years as well as pooled data. The result showed parity with the findings of Shahi *et al.*, (2017) and Latha *et al.*, (2019). The decline in K content might be due to three reasons viz., dilution effect, caused by higher dry matter production, low K status of soil and fixation of applied K. Irrespective of different growth stages, pooled data revealed that significantly higher K accumulation in mustard was observed in inorganic and organic N sources applied singly or in integration of both over control (Nehra and Grewal, 2001; Sultana *et al.*,

2015; Soheli *et al.*, 2016 and Bairwa and Yadav, 2017). This might be due to release of nutrients from organic sources thereby increasing soil availability along with inorganic source during the growing stage (Gautam *et al.*, 2013). Among the different treatments, significantly higher K content was observed in T₈ which was statistically at par with T₁₁ and T₄ on 60th, 90th DAS and at harvest.

On the basis of the results, it can be concluded that treatments receiving integrated nitrogen management significantly higher N, P and K content over the untreated control. However, with advancement of crop growth progressive decline in N, P and K concentration was observed during both the years of study. Application of integrated nitrogen management improved the macronutrient content of rapeseed (Toria var. M-27). Among the treatments, higher macronutrient accumulation was reported in T₄ which is at par with T₆, T₈ and T₁₁.

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