Original Research Article

Residual effect of Integrated Nutrient Management on growth and yield Toria in North Central Plateau Zone of Odisha

ABSTRACT

A field experiment on "Planting pattern and nutrient management in rainfed sweet corn + cowpea system and its residual effect on succeeding toria" was conducted during the *kharif* and *rabi* seasons of 2019-20 and 2020-21 at Regional Research and Technology Transfer Station, Keonjhar, Odisha. The experiment was laid down in Split plot design with three replications. The experiment was conducted to identify the suitable planting pattern and effect of nutrient management practices for enhancing production potentials of Sweet corn+ Cowpea and its effect on Toria. The treatments taken in this experiment consists of planting pattern with 3 levels i.e P_1 : Sweet corn +Cowpea (1:1) in alternate rows, P_2 : Sweet corn +Cowpea (2:2) in alternate paired rows and P_3 : Sweet corn +Cowpea (1:1) in the same row and nutrient management practices with seven levels i.e. F_1- STBFR to Sweet Corn , F_2- Proportionate of STBFR of (Sweet Corn + Cowpea) based on population, F_3- STBFR to Sweet Corn + Consortia biofertilizer , F_4- 75% STBFR to Sweet Corn + STBFR to Cowpea based on population, F_5- 50% STBFR of Sweet Corn + STBFR to Cowpea based on population, F_6- 75% STBFR of Sweet Corn + STBFR to Cowpea based on population + Consortia biofertilizer, F_7- 50 % STBFR of Sweet Corn + STBFR to Cowpea based on population + Consortia biofertilizer**.** Sweet corn variety 'Sugar 75', Cowpea variety 'Kashi kanchan' and Toria variety 'Anuradha' were used as test crops**.** The main objective of this experiment was to find out the residual effect on growth, yield attributes and yield of toria in the sequence. Before the harvest of the crop the observations on growth parameters were recorded. Height of the plant was taken at harvest and the number of leaves per plant were taken at an interval of , 45 and 60 days after sowing and number of primary and secondary branches per plant was recorded. After harvesting, yield attributes and yield (number of siliqua per plant, number of grains per siliqua, 1000 seed weight (gm), grain yield (t/ha), stover yield (t/ha), and harvest index (%)) were recorded. Planting of sweet corn + cowpea (2:2) in alternate paired rows(P_2) with application of 75% STBFR of Sweet Corn + STBFR to Cowpea based on population + Consortia bio fertilizer to the preceeding maize + cowpea crop (F_6) followed by STBFR of sweet corn and cowpea (F_2) was suprior in terms of both yield and yield parameters

***Key words*:** sweet corn, consortia bio fertilizer, growth parameters, yield

INTRODUCTION

In India, Toria (*Brassica campestris L.*) is cultivated in 6.34 m ha with a total production of 7.82 million tons and productivity of 1,234 kg/ha. Comparatively in Odisha rapeseed and Mustard is grown in an area of 116 thousand hectares. The total production comes to 49 thousand tonnes with a productivity of 422 kg ha-1 which is much below the national average of 1176 kg ha^{-1} [1] . The second important oil seed crop in India is rapeseed/mustard, after groundnut and cultivated on an area of about 7.20 Mha with the production of 8.01 MT and an average productivity of 1.11 MTha [2]. Toria is a short duration crop cultivated largely in Assam, Bihar, Orissa and West Bengal in the east mainly as winter crop and has wider adaptability and could suitably exploit residual moisture of rainy season [3] increase income and utilise the residual nutrients present in soil.

Kendujhar district coming under North central plateau zone is mainly a tribal dominated area with low crop yields due to poor soil fertility. The major crop of this area is maize followed by toria but the productivity is less than the national average because of non judicious application of the fertilizers by the farmers. Both maize and toria are nutrient-exhaustive crops and deplete the soil fertility extensively. Numerous nutrient deficiencies are also observed due to the poor recycling of organic sources [4]. Therefore if nutrients are judiciously applied to the preceding crop it will positively improve the growth and productivity of the succeeding crop. [5] reported that where 100% N was substituted through organic matter in the form of Vermicompost and FYM applied to the preceding crop improved the growth and yield attributing parameters of gobhi sarson and was followed by statistically similar values of all the parameters received with the treatment where 100% N was supplied through FYM. Similarly according to [6] grain yield of mustard increased significantly with increasing levels of inorganic fertilizers as well as with application organic manures to the preceding maize crop. Maximum mustard grain yields (4.64 q ha^{-1}) was attained with the full recommended fertilizer doses along with application of FYM, biofertilizer, and lime which was significantly greater than that under the control plots (0.22 q ha−1). The FYM directly added an appreciable amount of major micronutrients to the soil, which could contribute to the enhanced yield. [7] in a field experiment concluded that organic matter applied to preceding maize crop had a positive residual effect on gobhi sarson which improved yield attributes of plants raised in plots that had experienced substitution of nutrients through organic sources in the preceding maize.

In North central plateau zone of Odisha there is no proper systematized research work relating to the nutrient management in maize - toria system. The main objective of this experiment was to find out the residual effect on growth, yield attributes and yield of toria in the sequence, therefore the present investigation was ventured to study the nutrient management in rainfed sweet corn + cowpea system and its residual effect on succeeding toria

STUDY AREA

A field experiment entitled "Planting pattern and nutrient management in rainfed sweet corn + cowpea system and its residual effect on succeeding toria " was conducted at Field Experimental Block, Regional Research and Technology Transfer Station, Keonjhar, Odisha, India during *Kharif -Rabi* season of two consecutive years *i.e.* 2019-20 and 2020-21. The topography of the experimental site was medium high land and the soil was sandy loam with good drainage facility. The soil has pH (6.5), EC (0.13 dsm^{-1}), OC (0.75%), available nitrogen (288.2 kg ha-1), available phosphorus (18.4 kg ha-1) and available potassium (119.2 kg ha-1).

MATERIAL AND METHOD

The field experiment was laid out in split plot design with three replications and two factors, the first one being the planting pattern (Factor A) and the second one is nutrient management (Factor B). The planting pattern had 3 levels (P_1- Sweet Corn + Cowpea (1:1) in alternate rows , P_2- Sweet Corn + Cowpea (2:2) in alternate paired rows and P_3- Sweet Corn + Cowpea (1:1) within same row) and nutrient management had 7 levels(F_1- STBFR to sweet corn, F_2- Proportionate of STBFR of (sweet corn + cowpea) based on population, F_3- STBFR to sweet corn + Consortia bio fertilizer, F_4- 75% STBFR to sweet Corn + STBFR to cowpea based on population, F_5- 50% STBFR of sweet Corn + STBFR to cowpea based on population , F_6- 75% STBFR of sweet corn + STBFR to cowpea based on population + Consortia bio fertilizer and F_7- 50 % STBFR of sweet corn + STBFR to cowpea based on population + Consortia bio fertilizer). Blanket dose of FYM@ 5 t/ha will be given to all the treatments of sub plot. Altogether there were 21 treatment combinations. Toria was grown as residual crop with 100% STBFR fertilizer .

Sweet corn variety 'Sugar 75', Cowpea variety 'Kashi kanchan' and Toria variety 'Anuradha' were used as test crops. In *Kharif* sweet corn and cowpea were sown in the last week of June during both the years of experimentation. For sweet corn the seed rate was 10 kg ha-1 and for cowpea the seed rate was 20 kg ha-1. Line sowing was done by opening shallow furrows of uniform depth of about 3-5 cm . Two seeds were placed per hole. The spacing of the sweet corn and cowpea was taken as per the treatments. To all the plots well decomposed FYM was applied @ 5 t/ha. As per the treatments consortia bio fertilizer was mixed with FYM and applied as basal. Nitrogen was applied in the form of urea, Phosphorus as SSP and potassium in the form of MOP . These fertilizers were applied to the soil on soil test basis as per the treatments. In case of sweet corn, one third dose of N and full dose of P_2O_5 and half dose K_2O were applied as basal, the remaining one third dose of N and half dose of K_2O was applied as top dressing at knee height stage and the rest was applied at silking stage of the sweet corn. In case of cowpea all the fertilizers were applied as basal during the time of sowing as per the treatments in the different subplots. The other intercultural operations such as bund preparation, thinning, weeding and plant protection measures were also carried out as per package and practice.

In *Rabi* toria was sown during the last week of October during both the years . The seed rate was 6 kg ha^{-1} . Line sowing was done by opening shallow furrows of uniform depth. The row to row spacing was 30 cm and plant to plant spacing was 10 cm. The fertilizers were applied to the soil on soil test basis ., half dose of N and full dose of P_2O_5 and K_2O were applied as basal, the remaining half dose of N was applied as top dressing at 30 days after sowing. The other intercultural operations were carried out timely as per the recommended package and practices of OUAT.

Observations on yield and yield parameters were recorded before and at harvest Plant heights, number of leaves per plant were recorded at an interval of 30, 45, 60, DAS. The yield and yield parameters measured in the form of number of siliqua per plant, seeds per siliqua, 1000 seed weight (gm), seed yield (q/ha), stover yield (q/ha), and harvest index (%).

RESULT AND DISCUSSION

GROWTH PARAMETERS

In this investigation the maximum plant height at harvest was observed in sweet corn + cowpea (2:2) in alternate paired rows closely followed by sweet corn + cowpea (1:1) in alternate rows and sweet corn + cowpea (1:1) in the same row (Table 1), but the differences were not statistically significant. Among the nutrient management practices the application of (F6)75% STBFR of Sweet Corn + STBFR to Cowpea based on population + Consortia bio fertilizer to preceding maize crop and 100% application of STBFR to toria has been seen to record a significant and harmonious increase in plant height at harvest (92.8 cm) followed by (F2)STBFR of sweet corn and cowpea(88.15cm) and (F7) 50% STBFR to sweet corn + STBFR to cowpea + consortia bio fertilizer (84.15 cm). STBFR to sweet corn (F1) recorded the minimum plant height of 70.1 cm and was significantly less than the other treatments. The reason might be the role of organic bio fertilizers in improving the physio-chemical and biological properties of the soil. Not only that but these organic fertilizers have synergistic relationship with N and P, thereby helping in mineralization of applied N and P and helped in increasing the growth. These results are in accordance with the findings of [8,9]and [10] . Also the continued and balanced supply of nutrients enhanced the availability of the nutrients and with their active involvement in shoot and root development exhibited better plant growth [11]. Another reason might be due to the presence of microbes of the bio fertilizers which mobilize or increasing nutrient availability from highly persistent material i.e cellulose in FYM manure which requires long time for complete

decomposition. Thus release from farm yard manure for long period notably benefited the succeeding toria crop.

The data on number of leaves of toria at different periods were recorded and statistically analyzed and presented in Table1. With the increase in the crop age, there was increase in the number of green leaves up to 45 DAS and decreased thereafter. The pooled data revealed that planting pattern sweet corn + cowpea (2:2) in alternate paired rows reported the maximum number of green leaves (7.55, 25.90 and 15.3 at 30,45 and 60 DAS) followed by sweet corn + cowpea (1:1) in alternate rows. Sweet corn + cowpea (1:1) in the same row recorded the minimum number of leaves. Among the nutrient management practices, maximum number of green leaves per plant (8.65, 27.45 and 17.05 at 30,45 and 60 DAS) were recorded in the *Kharif* treatment receiving 75% STBFR to sweet corn + STBFR to cowpea + consortia bio fertilizer (F6) followed by STBFR of sweet corn and cowpea (F2) and 50% STBFR to sweet corn + STBFR to cowpea + consortia bio fertilizer(F7). The minimum number of leaves were found in the treatment where only STBFR to sweet corn was applied (F1)

The number of primary branches per plant and secondary branches per plant at harvest of toria varied significantly due to the residual effect of *Kharif* The pooled data is presented in Table 1.

Highest number of primary branches per plant was recorded with (P_3)sweet corn + cowpea (1:1) in the same row (5.1) which was at par with (P_2)sweet corn + cowpea (2:2) in alternate paired rows(4.9) but significantly different from sweet corn + cowpea (1:1) in alternate rows(P_1)

Maximum number of secondary branches per plant at harvest of toria was maximum with (P_2)sweet corn + cowpea (2:2) in alternate paired rows(5.4) followed by (P_1) sweet corn + cowpea (1:1) in alternate rows (Tableb 1).

Comparison of the pooled effect over the years of *nutrient management practices* showed maximum count of primary branches and secondary branches per plant at harvest where (F6) 75% STBFR to sweet corn + STBFR to cowpea + consortia bio fertilizer was applied during the kharif (6.6 and 7.1 respectively). This treatment was at par with STBFR of sweet corn and cowpea (F2) and 50% STBFR to sweet corn + STBFR to cowpea + consortia bio fertilizer(F7). This shows that the growth of the plant is positively affected by the potentiality of bio fertilizers to provide long term effect. This was in accordance with the results recorded by [12]. The least number of primary and secondary branches was observed when fertilizer was applied only to sweet corn during *kharif* (3.2 and 2.3 respectively)

Table 1. Effect of planting pattern and nutrient management on plant height at harvest and number of leaves at different growth stages of toria (2 years pooled data)

Treatments	**Plant height (cm)**	**Number of leaves plant-1**			**Primary branches**	**Secondary branches**
	At harvest	**30 DAS**	**45 DAS**	**60 DAS**		
M+C(1:1) in alternate rows	72.10	7.35	25.95	15.20	3.9	5.0
M+C(2:2) in alternate paired rows	74.05	7.55	25.90	15.30	4.9	5.4
M+C(1:1) in the same row	73.70	7.55	24.35	15.05	5.1	4.2
S.Em. (±)	0.7	0.1	0.1	0.1	0.1	0.1
CD(P=0.05)	NS	0.3	0.3	0.3	0.3	0.4

Nutrient management						
F1-STBFR(M)	70.10	6.50	22.30	11.35	3.2	2.3
F2- STBFR of (M+C)	88.15	8.20	26.85	16.30	5.8	6.5
F3- STBFR(M)+C.bf	80.10	7.45	25.65	14.75	5.4	4.5
F4-75% STBFR(M)+ STBFR(C)	76.80	7.05	24.85	13.50	4.7	3.9
F5-50% STBFR(M)+ STBFR(C)	74.15	6.85	23.90	12.85	4.1	3.4
F6-75% STBFR(M)+ STBFR(C) +C.bf	92.80	8.65	27.45	17.05	6.6	7.1
F7-50% STBFR(M)+ STBFR(C) +C.bf	84.15	7.80	26.30	15.60	5.6	6.0
S.Em. (±)	2.5	0.1	0.6	04	0.1	0.1
CD(P=0.05)	6.9	0.3	1.8	1.1	0.4	0.4

NB: M= Sweet corn, C= cowpea, STBFR= soil test based fertilizer recommendation, C.bf= Consortia biofertilizer

Table 2. Effect of planting pattern and nutrient management on number of primary branches and secondary branches at harvest , number of siliquae plant-1, seeds siliquae-1 and 1000 seed weight (g) of toria. (2 years pooled data)

Treatments	Siliquae plant-1	Seeds siliquae-1	1000 seed weight (g)
M+C(1:1) in alternate rows	82.6	8.7	3.82
M+C(2:2) in alternate paired rows	87.7	9.1	3.85
M+C(1:1) in the same row	80.4	8.6	3.80
S.Em. (±)	0.1	0.1	0.02
CD(P=0.05)	0.3	0.1	NS
Nutrient management			
F1-STBFR(M)	56.6	6.1	3.66
F2- STBFR of (M+C)	87.2	8.5	3.87
F3- STBFR(M)+C.bf	69.5	7.5	3.81
F4-75% STBFR(M)+ STBFR(C)	62.3	7.0	3.77
F5-50% STBFR(M)+ STBFR(C)	57.3	6.4	3.75
F6-75% STBFR(M)+ STBFR(C) +C.bf	89.5	9.3	3.91
F7-50% STBFR(M)+ STBFR(C) +C.bf	86.0	8.7	3.83
S.Em. (±)	1.8	0.1	0.04
CD(P=0.05)	5.3	0.4	NS

Yield attributes

The residual effect of treatments imposed to mustard cv. 'Anuradha' during the *Kharif* season showed significant effect on number of siliquae plant-1 and Seeds siliquae-1 whereas the effect was non significant with 1000 seed weight (Table 2).

The pooled outcome of the experiment revealed that the number of siliquae per plant, seeds per siliquae was maximum with sweet corn + cowpea (2:2) was planted in alternate paired rows in

kharif , closely followed by sweet corn + cowpea (1:1) in alternate rows. The least number of siliquae per plant was observed in the planting pattern with sweet corn + cowpea (1:1) in the same row.

Among the nutrient management practices the application of 75% STBFR of Sweet Corn + STBFR to Cowpea based on population + Consortia bio fertilizer to the preceding maize + cowpea crop (F6) increased the yield attributes of toria i.e no of siliqua plant-1 (89.5) , no of seeds siliqua-1(9.3) , 1000-seed weight (3.91 g). This treatment was at par with (F2) STBFR of sweet corn and cowpea (87.2, 8.5 and 3.87g) and (F7) 50% STBFR to sweet corn + STBFR to cowpea + consortia bio fertilizer (86.0, 8.7 and 3.83g respectively). The least number of siliquae plant-1 , seeds siliquae-1 and 1000 seed weight was observed when fertilizer was applied only to sweet corn during *kharif* (56.6, 6.1 and 3.66 g respectively) (Table 2).

The FYM and bio fertilizers applied to the preceding crop directly added a considerable amount of major micronutrients to the soil, which contributed in enhancing the yield attributes. Also the improved soil physical properties such as water-holding capacity and moisture retention resulting from addition of FYM, and biofertilizer provided a desirable soil condition for the root development, enhanced nutrient uptake, crop growth, yield and yield attributing characters. This was in close confirmity with [13] who recorded the highest number of siliqua/plant, 1000 seed weight and seed yield in mustard with residual effect of *Azolla* compost 5 tonnes/ha + farmyard manure 5 tonnes/ha applied to preceding maize crop. This effect was at par with residual effect of 100% NPK + *Azolla* compost or farmyard manure 2.5 tonnes/ha as well as 50% NPK + *Azolla* compost or farmyard manure 5 tonnes/ha. Similar observation of higher yield attributes of succeeding crop of mustard with 100% of the recommended dose of nutrient substituted through farmyard manure during kharif in maize were recorded which was comparable with the treatment where the recommended dose was given 50% each through fertilizer and farmyard manure to maize have been reported by [14].

Yield

Perusal of data on seed yield and stover yield and Harvest index of toria exhibited significant variations due to residual effect of *Kharif* treatments imposed on sweet corn and cowpea grown in intercropping method and the pooled data is presented in Table 3.

Sweet corn + cowpea (2:2) in alternate paired rows (P_2) produced higher seed and stover yield and harvest index followed by sweet corn + cowpea (1:1) in alternate rows (P_1) and minimum seed yield with sweet corn + cowpea (1:1) in the same row (P_3).

Among the *Kharif* , nutrient management treatments supplied with (F6) 75% STBFR to sweet corn + STBFR to cowpea + consortia bio fertilizer gave the maximum seed yield of 0.82 t/ha, stover yield of 1.43 t/ha and harvest index of 36.6% followed by (F2)STBFR to sweet corn + cowpea(0.80 t/ha , 1.40 t/ha and 36.2% respectively). The least seed yield and stover yield and Harvest index of toria was recorded with (F1) STBFR to sweet corn (0.48 t/ha , 1.02 t/ha and 31.7 % respectively)

Application of nitrogen in the form of chemical fertilizers along with bio fertilizers and FYM played a major role in cytokinin synthesis, thereby increasing the number of effective tillers and better root growth coupled with higher photosynthetic area which in turn helped in better growth and development and ultimately higher seed and stover yield. Release of phosphorus by the bio fertilizers also played a vital role in root development, energy transformation and metabolic processes of plant, which resulted in greater translocation of photosynthates towards the sink development. These are in close conformity with those of[15 & 16] . Similarly [17] reported highest seed and stover of mustard with 100% RDF + vermicompost @ 2 t/ha + 20 kg S/ha + 4 kg

Zn/ha + seed treatment with bio fertilizers to the preceding maize crop. Saha et al., 2010 too reported maximum maize and mustard grain yields (36.44 and 4.64 q ha−1, respectively) with the full recommended fertilizer doses along with application of FYM, biofertilizer, and lime. [13] observed that the seed yield of mustard obtained with residual effect of *Azolla* compost 5 tonnes/ha + farmyard manure 5 tonnes/ha in kharif maize was 99% and 37% higher than yield obtained with residual control and recommended NPK, respectively. Beneficial effect of fertililzers in organic form alone or in combination with inorganic fertilizer applied to preceding crop on the productivity of succeeding crop was also observed by [18]. Similarly [19] recorded the highest mustard yield (24.88 q/ha) in rabi with the application of 100 percent recommended N in the rainy season to Maize crop through FYM

Table 3. Effect of planting pattern and nutrient management on seed yield, stover yield and harvest index of toria. (2 years pooled data)

Treatments	Seed yield (t ha-1)	Stover yield (t ha-1)	Harvest index (%)
M+C(1:1) in alternate rows	0.79	1.45	35.5
M+C(2:2) in alternate paired rows	0.81	1.46	35.8
M+C(1:1) in the same row	0.76	1.37	35.8
S.Em. (±)	0.02	0.04	0.2
CD(P=0.05)	0.06	0.12	NS
Nutrient management			
F1-STBFR(M)	0.48	1.02	31.7
F2- STBFR of (M+C)	0.80	1.40	36.2
F3- STBFR(M)+C.bf	0.71	1.30	35.4
F4-75% STBFR(M)+ STBFR(C)	0.68	1.22	35.7
F5-50% STBFR(M)+ STBFR(C)	0.61	1.18	33.9
F6-75% STBFR(M)+ STBFR(C) +C.bf	0.82	1.43	36.6
F7-50% STBFR(M)+ STBFR(C) +C.bf	0.76	1.33	36.0
S.Em. (±)	0.015	0.02	0.5
CD(P=0.05)	0.04	0.08	NS

CONCLUSION

From the above results, it may be concluded that the application of 75% STBFR of sweet corn + STBFR to cowpea based on population + consortia bio fertilizer to the preceding maize + cowpea crop (F6) was better in terms of yield and yield parameters. This combination is favourable to sustain soil fertility and reduce environmental pollution from the use of chemical fertilizers alone. In such situation complementary use of both organic and inorganic fertilisers is recommended to enhance the productivity of the crops as well as soil fertility.

REFERENCES

1. Pati, P., Mahapatra, P.K. Yield performance and nutrient uptake of Indian mustard (Brassica juncea L) as influenced by integrated nutrient management. Journal Crop and Weed. 2015; 11(1):58-61.

2. USDA:http://apps.fas.usda.gov.Foreign Agricultural Service (FAS), U. S. Department of Agriculture.2019

3. Gupta Vikas, Sharma Anil, Kumar Jai, Abrol Vikas, Singh Brinder And Singh Mahender (2014). Effects of integrated nutrient management on growth and yield of maize (Zea mays L.) - Gobhi sarson (Brassica napus L.) cropping system in sub-tropical region under foothills of north-west Himalayas. Bangladesh J. Bot. 43(2): 147-155.

4. Kumar, A. Influence of varying plant population and nitrogen levels on growth, yield, economics and nitrogen use efficiency of popcorn (*Zea mays* evertasturt). Crop Research. 2008; 37: 19-23.

5. Brinder Singh., Anil Kumar., Vikas Gupta., Vikas Abrol., A.P. Singh., Jai Kumar., Mahender Singh., Hemant Dadhich. and Permendra Singh. Effect of organic and inorganic nutrients on pearl millet (*Pennisetum glaucum*)-gobhi sarson (*Brassica napus* var. napus) cropping sequence. Indian Journal of Agricultural Sciences. 2020; 90 (2): 302–6.

6. Saha, R., Mishra, V. K., Majumdar, B., Laxminarayana, K.and Ghosh, P.K. Effect of Integrated Nutrient Management on Soil Physical Properties and Crop Productivity under a Maize (*Zeamays*)–Mustard (*Brassicacampestris*) Cropping Sequence in Acidic Soils of Northeast India, ommunications in Soil Science and Plant Analysis. 2010; 41:18, 2187-2200.

7. Gupta, Vikas., Sharma Anil., Kumar Jai., Abrol Vikas., Singh Brinder. and Singh Mahende.r Effects of integrated nutrient management on growth and yield of maize (Zea mays L.) - Gobhi sarson (Brassica napus L.) cropping system in sub-tropical region under foothills of north-west Himalayas. Bangladesh J. Bot. 2014; 43(2): 147-155.

8. Satyajeet and Nanwal R.K. Integrated nutrient management in pearlmillet-mustard cropping system. Indian Journal of Fertilizer. 2007; 3(4) : 59-62.

9. Meena LR, Singh RK, Gautam RC. Effect of conserved soil moisture, phosphorus levels and bacterial inoculation on dry matter production and uptake pattern of phosphorus by chickpea. Indian J. Pulse Res. 2001; 18:32-35.

10. Meena M. D, Tiwari D. D, Chaudhari S. K, Biswas D. R, Narjary B, Meena A. L, Meena B. L. and Meena R. B. Effect of Biofertilizer and Nutrient Levels on Yield and Nutrient Uptake by Maize (*Zea mays* L.). Annals of Agri-Bio Research. 2013; 18 (2) : 176-181.

11. Parihar, C.M. Rana, K.S. and Kantwa, S.R. Nutrient management in pearl millet (Pennisetum glaucum)–mustard (Brassica juncea) cropping system as affected by land configuration under limited irrigation. Indian Journal of Agronomy. 2010; 55 (3): 191- 196.

12. Singh, R. and Totawat, K. L. Effect of integrated use of nitrogen on the performance of maize (Zea mays L.) on halplustalfs of sub-hamid southern plains of Rajasthan. Indian J. Agric. Res. 2002; 36 : 102-107.

13. Das, A., Baiswar, P., Patel, D. P., Munda, G. C., Ghosh, P. K. and Chandra, S. Productivity, nutrient harvest index, nutrient balance sheet and economics of lowland rice (*Oryza sativa*) as influenced by composts made from locally available plant biomass. Indian Journal of Agriculture Science. 2010; **80**(8):686–90.

14. Panwar AS. Effect of Integrated Nutrient Management in Maize (*Zea mays*)-Mustard (*Brassica compestris* var *toria*) Cropping System in Mid Hills Altitude. Indian Journal of Agricultural Sciences. 2008; 78(1):27-31.

15. Mahala, H.L., Shaktawat, M.S. and Shivran, R.K.. Direct and residual effect of sources and levels of phosphorus and farmyard manure in maize (Zea mays) - mustard (*Brassica juncea*) cropping sequence. Indian Journal of Agronomy. 2006; 51: 10-13.

16. Satyajeet and Nanwal RK. Integrated nutrient management in pearlmillet-mustard cropping system. Indian Journal of Fertilizer. 2007; 3(4) : 59-62 & 76.

17. Priyanki, Bora., Nayan Jyoti Ojha. and Anjali Basumatary. Effect of Integrated Nutrient Management on Nutrient Content and Uptake by Late Sown toria (Brassica campestris var oria) and Availability of Nutrients in the Soil. Int.J.Curr.Microbiol.App.Sci. 2020; 9(12): 920-928.

18. Das Anup, Prasad M, Shivay Y S and Subha K M. Productivity and sustainability of cotton *(Gossypium hisrutum* L.)–wheat *(Triticum aestivum* L.) cropping system as influenced by prilled urea, farmyard manure and *Azotobacter*. Journal of Agronomy and Crop Science. 2004; 190: 298–304.

19. Kumpawat, B.S. Integrated nutrient management for maize (*Zea mays*)-Indian mustard (*Brassica juncea*) cropping system. Ind. J. Agron. 2004; 49: 18-21.