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Influence of Varieties and Integrated Nutrient Management on Growth Physiological Parameters of Isabgol (*Plantago ovata* Forsk.) under Northern Dry Zone of Karnataka, India

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ABSTRACT

The field experiment was conducted to evaluate the performance of growth physiological parameters of Isabgol varieties with integrated nutrient management under northern dry zone of Karnataka during two years 2015-16 and 2016-17. The experiment was laid out in split plot design (SPD) with the two Isabgol varieties and sixteen INM sub treatment combinations at the College of Horticulture, Bagalkot. grown in northern dry zone of Karnataka, analysis did with pooled data exhibited higher value was recorded in Vallabh Isabgol-1in growth parameters *viz.*, LAI (2.74), dry matter production (8.72q ha^{-1}), CGR(0.1103 $gm^{-2}day^{-1}$), RGR(0.0780g $g^{-1}day^{-1}$), seed yield (12.30 q ha^{-1}) as compared to Gujarat Isabgol-2 (11.05 kg ha^{-1}). Whereas the higher INM treatments values recorded with respect to plant growth parameters were observed in *Viz.* **N_{11}**-75 % RD of FYM **(**7.5 t ha^{-1}) + 75% RD of NPK (37.5:18.75:22.50 kg ha^{-1}) +*Azospirillum* (5kg ha^{-1}) + *PSB* (3kg ha^{-1}) + $ZnSO_4$ (15 kg ha^{-1}) + $FeSO_4$ (7.5 kg ha^{-1}) *viz.*, higher values for interaction effect on growth physiological parameters were recorded in V_1 N_{11}.*viz.*, leaf area Index (3.43), dry matter (9.26 q ha^{-1}), CGR (0.1103g m^{-2} day^{-1}), RGR (0.0780 g g^{-1} day^{-1}), seed yield (15.43 q ha^{-1}).

Introduction

Isabgol is an annual herb grown during the *rabi* season, seed coat is known as husk under trade. The swelling property of the husk due to after absorption of water it is used in medicine against constipation and gastrointestinal disorders and food industries for the preparation of ice creams, creams, candy *etc*. It produces around 90,000 to 1,00,000 tonnes of Isabgol every year of which Gujarat accounts for around 22-26 per cent share. The productivity of the crop has remained in the range of 632 kg to 672 kg per hectare in the state. It is commercially cultivated in Gujarat, Rajasthan and Madhya Pradesh.

Largely grown in western Rajasthan over about 2400 ha land around Jaisalmer. In Madhya Pradesh, it is grown mainly in Neemuch and Mandsaur districts, covering an area of 7,448 ha, the total production of 10,427.20 tonnes and productivity of 1.40 MT q ha^{-1}. Gujarat accounts for around 22 to 26 per cent share. (Anon, 2016a). During 2014-15, about 62,000 MT of Isabgol seeds were traded at Unjha mandi at an average rate of ₹100 kg^{-1}. The rates varied from a low of ₹ 1600 q^{-1} to ₹ 2500 q^{-1} depending upon the quality of the seed (Sen and Chakraborty, 2017).

In our state Karnataka, Isabgol cultivation is very meager only local cultivars are grown with poor yield. There is a wide yield gap between local cultivars and high yielding varieties. Performance of any crop or variety depends upon inherent genetic potential make up of variety and response to climatic condition of the zone. To attain increased productivity, studies on INM have been carried out with an aim to identify suitable cultivar.

Materials and Methods

The experiment was conducted in the field at Department of Plantation Spices Medicinal and Aromatic Plants, College of Horticulture, Bagalkot at Haveli farm during the years 2015-16 and 2016-17. Geographically, this experimental site lies in Northern Dry Zone (Zone-3) of Karnataka state in the agro-climatic zone of Karnataka, situated at 16° North latitude and 74°59’ East longitude and at an altitude of 533.0 m above mean sea level

The soil of experimental field was red clay loamy in texture, with percentages of sand 22.60, silt 26.10 and clay52.20 bulk density 1.25, EC 0.24 dS m^{-1} and pH 8.22 (alkaline in reaction) with organic carbon 1.63 and available 268.02, 34.80, 273.69 NPK kg ha^{-1}.

The source of seed collection was DMAPR Anandh Gujarat *i.e.* Vallabh Isabgol-1 (V1) and Gujarat Isabgol-2 (V_2). Seed were sown in 18 November 2015 and 2016 with gross plot size of 3.6 m x 1.5 m = 5.40 m^2 in split plot design in sixteen INM sub treatments with three replications as subplot listed below as per the experiment conducted.

N_1 -RDF FYM **(**10 t ha^{-1}) + RDF NPK (50:25:30 kg ha^{-1})
N_2-RDF FYM **(**0 t ha^{-1}) + RDF NPK (50:25:30 kg ha^{-1}) +$ZnSo_4$ (15 kg ha^{-1})
N_3-RDF FYM **(**10 t ha^{-1}) + RDF NPK (50:25:30 kg ha^{-1}) +$FeSo_4$ (7.5 kg ha^{-1})
N_4-RDF FYM **(**10 t ha^{-1}) + RDF NPK (50:25:30 kg ha^{-1}) +$FeSo_4$ (7.5 kg ha^{-1}) + $ZnSo_4$ (15 kg ha^{-1})
N_5-Vermicompost (1 t ha^{-1}) + RDF NPK (50:25:30 kg ha^{-1})
N_6-Vermicompost (1tha^{-1}) +50% RDF NPK (50:25:30 kg ha^{-1})+*Azospirillum*(5kg ha^{-1}) + *Azotobacter* (5kg ha^{-1})
N_7-75% RD FYM **(**7.5 t ha^{-1}) + 75% RDF NPK (37.5:18.75:22.50 kg ha^{-1})
N_8-75% RD FYM **(**7.5 t ha^{-1}) +75% RDF NPK (37.5:18.75:22.50 kg ha^{-1}) + *Azotobacter* (5kg ha^{-1})
N_9-75% RD FYM **(**7.5 t ha^{-1}) +75% RDF NPK (37.5:18.75:22.50 kg ha^{-1})+ *Azospirillum* (5kg ha^{-1}) **N_{10}**-75% RD FYM **(**7.5 t ha^{-1}) +75% RDF NPK (37.5:18.75:22.50 kg ha^{-1}) + *PSB* (3kg ha^{-1})
N_{11}-75%RDF FYM **(**7.5tha^{-1}) + 75% RDF NPK (37.5:18.75:22.50kg ha^{-1})+ *Azospirillum*(5kg ha^{-1})+ *PSB* (3kg ha^{-1})+ $ZnSo_4$(15kg ha^{-1}) + $FeSo_4$ (7.5 kg ha^{-1})
N_{12}-50%RDF FYM (5t ha^{-1}) + 50% RDF NPK (25:12.5:15 NPK kg ha^{-1})
N_{13}-50% RD FYM (5t ha^{-1}) +50% RDF NPK (25:12.5:15 kg ha^{-1}) +*Azotobacter* (5kg ha^{-1})
N_{14}-50% RDF FYM (5t ha^{-1}) +50% RDF NPK (25:12.5:15 kg ha^{-1}) +*Azospirillum* (5kg ha^{-1})
N_{15}-50% RD FYM (5tha^{-1}) +50% RDF NPK (25:12.5:15 kg ha^{-1}) +*PSB* (3kg ha^{-1})
N_{16}-50%RD FYM (5t ha^{-1}) +75% RDF NPK

(37.5:18.75:22.50 kg ha^{-1}) + *Azospirillum* (5 kg ha^{-1}) +*PSB* (3kg ha^{-1})+$Znso_4$ (15 kg ha^{-1})+$FeSo_4$(7.5 kg ha^{-1}).

The experiment after layout then treatments were applied as per above nutrient combination, then mixed thoroughly in plots before imposing the treatments. Zinc was applied in the form of $ZnSO_4$ at the time of sowing half dose of N was applied as a basal and remaining half was applied one month after sowing as top dressing full dose of P and K were applied at the time of sowing below the seed in furrows made with the help of land hoe. Manual thinning weeding and hoeing were done at one month after sowing to provide an ideal environment to the crop a light irrigation was given immediately before sowing, however six and seven irrigation were given as per requirement of the crop with the help of sprinkler.

Five plants were selected randomly in each plot, were recorded dry matter of plants per meter row length growth parameter were recorded at the time of harvest in each plot at all the stages of crop however the growth parameters were recorded at harvest stages values were discussed here for

Leaf area index (LAI)

The leaves of five randomly selected plants were separated and leaf area was measured with the help of digital leaf area meter. Leaf area index was calculated as suggested by Watson (1958).

$$\text{LAI} = \frac{\text{Leaf area per plant (cm}^2\text{)}}{\text{Land area per plant (cm}^2\text{)}}$$

Crop growth rate (CGR g g^{-1} day^{-1})

It is the absolute growth rate per unit area of the ground. It was calculated after computing the dry weight of the plants per square meter. CGR was worked out at 30-60, 60-90 and 90-120 DAS by using the formula suggested by Watson (1952) and expressed in grams per m^2 per day.

$$\text{CGR} = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{1}{P}$$

Where, W1, W2 = Dry weight of plant in grams at time t_1 and t_2, respectively

P = Land area in cm^2

Relative growth rate (RGR g g^{-1} day)

It is the rate of increase in dry weight per unit dry weight per unit time. The relative growth rate was determined by using the formula suggested by Williams (1946) and expressed in grams per day.

$$\text{RGR} = \frac{(\text{Log}_e W_2 - \text{Log}_e W_1)}{t_2 - t_1}$$

Where, Log_e = Logarithm to the base e

W_1 and W_2 = Dry weight of plant at time t_1 and t_2, respectively

Dry matter production (q ha^{-1}) analysis the mean values of all the observations were worked out. Five plants were selected in each plot and cut at ground level at 30th, 60th, 90th and till at harvest stage.

After recording their fresh weight, the samples were dried under shade followed by hot air oven at 65°C temperature till constant weight was obtained and oven dry weights were recorded. The dry matter production was worked out by multiplying the dry weight of single plant with corresponding plant density per hectare.

In order to test the significance of variation the data were statically analysed as per procedure described by Panse and Sukhatme (1985). The critical differences were calculated to assess the significance of treatment means ($P < 0.05$).

Results and Discussion

At harvest stage growth physiological parameters were significantly higher *viz.*, dry matter production (8.72 q ha^{-1}), leaf area index (2.74) (CGR between 90-at harvest (0.1103g m^{-2} day^{-1}), RGR (0.0.0780 g $g^{-1}day^{-1}$), seed yield (12.30q ha^{-1}) was recorded with Vallabh Isabgol-1.

This results due to varietal performance to different agroclimatic conditions and genetical characteristics of particular variety and their difference in genotypic factor and adaptability of particular variety to soil and climatic conditions and the increased number of leaves, leaf area and number of tillers helped in better synthesis of carbohydrates and their utilization for build up of new cells, apart from better absorption of nutrients resulting in increased dry matter production were reported by several workers (Kumar *et al.*, 2009, Shirvan *et al.*, 2016a and Tyagi *et al.*, 2016) and lowest leaf area index (2.64),dry matter production (8.53 q ha^{-1}), seed yield (11.05 q ha^{-1}), between 90-at harvest CGR (0.1032 g m^{-2} day^{-1}), RGR (0.0752g $g^{-1}day^{-1}$) as recorded in Gujarat Isabgol-2 during pooled data respectively.

Integrated nutrient management

Significantly higher CGR between 90 DAS- at harvest, (0.1306 g m^{-2} day^{-1}) was recorded in N_{11} (75 % RD of FYM + 75 % RD of NPK + *Azospirillum* + *PSB* + $ZnSO_4$ + $FeSO_4$) which was on par with N_{16} (0.1251 g m^{-2} day^{-1}) and N_6 (0.1244 g m^{-2} day^{-1}) and N_4 (0.1179). Lower CGR (0.0862 g m^{-2} day^{-1}) was recorded in N_{13} in pooled data.

Significantly higher RGR (g $g^{-1}day^{-1}$) between 90 DAS- at harvest stage, (0.0878 g $g^{-1}day^{-1}$) was recorded in N_{11} (75 % RD of FYM + 75 % RD of NPK + *Azospirillum* + *PSB* + $ZnSO_4$ + $FeSO_4$) which was on par with N_4 (0.0874 g $g^{-1}day^{-1}$), N_{16} (0.0846 g $g^{-1}day^{-1}$) and N_6 (0.0842 g $g^{-1}day^{-1}$).Whereas the lower (0.0582 g $g^{-1}day^{-1}$) RGR were recorded in $N_{13.}$ Similar trend was recorded in pooled data INM application helps to plants absorb more nutrients increase leaf area then leads to increase the RGR further it helps for further more conversion of dry matter production in plant. Similar findings reported by Patel and Saravanan (2010) and Shivran *et al.*, (2016 a).

The significantly higher dry matter production at harvest (9.26 q ha^{-1}) was recorded in N_{11} (75 % RDF FYM + 75% RDF NPK + *Azospirillum* + *PSB* + $ZnSO_4$ + $FeSO_4$) which was on par with N_{16} (9.17 q ha^{-1}), N_6 (9.17 q ha^{-1}) and N_4 (9.13 q ha^{-1}). Further the lower dry matter production (8.29 q ha^{-1}) was recorded in N_{13} it is also due to the application of FYM in combination with NPK fertilizers resulting in more nutrients released at an optimum rate and faster rate. Which helps in maintaining continuous supply of nutrients to the plant leading to the greater availability of nutrients further possible to enhanced the meristematic activity in remunerative for getting higher plant growth, which positively correlated towards increase in physiological growth parameters to conversion of dry matter production in plants.

Further micro nutrient Zinc element application helps the plant especially in its role in initiation of primordia for reproductive parts and partitioning of photosynthetic towards then resulted in better number of spikes and capsule production of plant, which shows the positive effect with respect to plant growth, which attributes to the fact that zinc favours the enzyme system, auxin and protein synthesis and seed production.

Similar results obtained by Kattimani (1999), Ahirwar, (2014), Choudhary *et al.*, (2014), Nadukeri *et al.*, (2014), Shivran *et al.*, (2014) and Shivran *et al.*, (2015).

Table.1 Growth parameters on dry matter production (q per hactare) and Leaf area index as influenced by Isabgol varieties and integrated nutrient management

Varieties Nutrients	dry matter production									Leaf area index								
	2015			2016			Pooled data			2015			2016			Pooled data		
Nutrients	**V_1**	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**
N_1 - RDF FYM + RDF NPK (kg ha^{-1})	8.72	7.97	**8.34**	8.56	8.12	**8.34**	8.64	8.04	**8.34**	2.51	2.37	**2.44**	2.53	2.41	**2.47**	2.52	2.39	**2.45**
N_2 RDF FYM + RDF NPK+ $ZnSo_4$	8.69	8.48	**8.59**	8.60	8.37	**8.49**	8.65	8.43	**8.54**	2.65	2.20	**2.42**	2.80	2.37	**2.59**	2.72	2.29	**2.51**
N_3 RDF FYM + RDF NPK+$FeSo_4$	8.70	8.24	**8.47**	8.55	8.27	**8.41**	8.63	8.26	**8.44**	2.66	2.59	**2.62**	2.80	2.66	**2.73**	2.73	2.62	**2.68**
$N_4$75% RDF FYM + 75% RDF NPK + AZB	9.09	9.15	**9.12**	9.18	9.11	**9.14**	9.13	9.13	**9.13**	3.28	3.10	**3.19**	3.31	3.17	**3.24**	3.30	3.14	**3.22**
N_5 Vermicompost (1 t ha^{-1}) + RDF NPK	8.74	8.37	**8.55**	8.56	8.36	**8.46**	8.65	8.36	**8.51**	2.46	2.51	**2.48**	2.54	2.61	**2.58**	2.50	2.56	**2.53**
N_6 Vermicompost + 50% RDF NPK + ASP + AZB	9.18	9.25	**9.21**	9.15	9.10	**9.13**	9.16	9.18	**9.17**	3.32	3.17	**3.25**	3.49	3.24	**3.37**	3.41	3.21	**3.31**
$N_7$75% RDF FYM + 75% RDF NPK	8.52	8.42	**8.47**	8.52	8.37	**8.44**	8.52	8.40	**8.46**	2.52	2.26	**2.39**	2.69	2.34	**2.52**	2.61	2.30	**2.46**
$N_8$75% RDF FYM + 75% RDF NPK + AZB,	8.49	8.44	**8.46**	8.43	8.53	**8.48**	8.46	8.48	**8.47**	2.65	2.16	**2.41**	2.75	2.29	**2.52**	2.70	2.23	**2.46**
$N_9$75 % RDF FYM +75% RDF NPK +ASP	8.66	8.34	**8.50**	8.66	8.29	**8.47**	8.66	8.31	**8.48**	2.32	2.36	**2.34**	2.44	2.48	**2.46**	2.38	2.42	**2.40**
N_{10}75% RDF FYM + 75% RDF NPK + PSB	8.62	8.31	**8.46**	8.64	8.29	**8.46**	8.63	8.30	**8.46**	2.34	2.23	**2.28**	2.16	2.35	**2.25**	2.25	2.29	**2.27**
N_{11}50% RDF FYM + 50% RDF NPK + PSB	9.27	9.21	**9.24**	9.32	9.25	**9.28**	9.30	9.23	**9.26**	3.38	3.35	**3.36**	3.64	3.34	**3.49**	3.51	3.34	**3.43**
N_{12}50% RDF FYM + 75% RDF NPK + ASP + PSB + $ZnSo_4$ + $FeSo_4$	8.48	8.39	**8.43**	8.45	8.40	**8.42**	8.46	8.39	**8.43**	2.51	2.25	**2.38**	2.66	2.75	**2.71**	2.59	2.50	**2.55**
N_{13}50% RDF FYM + 50% RDF NPK + AZB	8.43	8.15	**8.29**	8.36	8.21	**8.29**	8.40	8.18	**8.29**	2.15	1.91	**2.03**	2.31	2.68	**2.50**	2.23	2.29	**2.26**
N_{14}50% RDF FYM + 50% RDF NPK + ASP	8.63	8.34	**8.49**	8.56	8.39	**8.47**	8.60	8.37	**8.48**	2.46	2.48	**2.47**	2.67	2.62	**2.64**	2.56	2.55	**2.56**
N_{15} 50% RDF FYM + 50% RDF NPK + PSB	8.43	8.27	**8.35**	8.47	8.33	**8.40**	8.45	8.30	**8.38**	2.34	2.79	**2.56**	2.67	2.85	**2.76**	2.51	2.82	**2.66**
N_{16}50% RDF FYM + 75% RDF NPK + ASP + PSB + $ZnSo_4$ + $FeSo_4$	9.24	9.22	**9.23**	9.18	9.05	**9.12**	9.21	9.13	**9.17**	3.27	3.29	**3.28**	3.43	3.36	**3.40**	3.35	3.33	**3.34**
MEAN	**8.74**	**8.53**		**8.70**	**8.53**		**8.72**	**8.53**		**2.68**	**2.56**		**2.81**	**2.72**		**2.74**	**2.64**	
	S.Em ±	**C.D at 5%**		**S.Em ±**	**C.D at 5%**		**S.Em ±**	**C.D at 5%**		**S.Em ±**	**C.D at 5%**		**S.Em ±**	**C.D at 5%**		**S.Em ±**	**C.D at 5%**	
Varieties (V)	**0.024**	**0.072**		0.016	**0.048**		**0.017**	**0.051**		0.067	**NS**		0.046	**NS**		**0.056**	**NS**	
Nutrients (N)	**0.074**	**0.21**		0.050	**0.14**		**0.059**	**0.17**		0.087	**0.25**		0.108	**0.31**		**0.088**	**0.25**	
N at same V	**0.105**	**0.30**		0.070	**0.20**		**0.084**	**0.24**		0.123	**NS**		0.153	**NS**		**0.125**	**NS**	
Vat same or different N	**0.097**	**0.27**		0.064	**0.18**		**0.067**	**0.19**		0.262	**NS**		0.181	**NS**		**0.220**	**NS**	

Table.2 Growth parameters on leaf area index, CGR (g g^{-1}per day) and RGR (g g^{-1} day) as influenced by Isabgol varieties and integrated nutrient management

Varieties / Nutrients	CGR (g g^{-1}per day) 90-at harvest								
	2015			2016			Pooled data		
Nutrients	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
N_1	0.1119	0.1042	**0.1080**	0.1126	0.1030	**0.1078**	0.1123	0.1036	**0.1079**
N_2	0.1037	0.1030	**0.1034**	0.1082	0.0985	**0.1034**	0.1060	0.1008	**0.1034**
N_3	0.1020	0.0988	**0.1004**	0.1087	0.1005	**0.1046**	0.1054	0.0997	**0.1025**
N_4	0.1061	0.1186	**0.1124**	0.1239	0.1231	**0.1235**	0.1150	0.1209	**0.1179**
N_5	0.0932	0.0943	**0.0937**	0.1085	0.1024	**0.1055**	0.1008	0.0984	**0.0996**
N_6	0.1176	0.1201	**0.1188**	0.1498	0.1101	**0.1299**	0.1337	0.1151	**0.1244**
N_7	0.1118	0.0951	**0.1035**	0.1141	0.1045	**0.1093**	0.1129	0.0998	**0.1064**
N_8	0.0999	0.0953	**0.0976**	0.1133	0.1031	**0.1082**	0.1066	0.0992	**0.1029**
N_9	0.1116	0.0930	**0.1023**	0.1153	0.0937	**0.1045**	0.1135	0.0933	**0.1034**
N_{10}	0.1209	0.1073	**0.1141**	0.1120	0.1129	**0.1124**	0.1164	0.1101	**0.1133**
N_{11}	0.1311	0.1240	**0.1276**	0.1389	0.1284	**0.1337**	0.1350	0.1262	**0.1306**
N_{12}	0.0841	0.0945	**0.0893**	0.0934	0.0989	**0.0962**	0.0888	0.0967	**0.0927**
N_{13}	0.1020	0.0748	**0.0884**	0.0837	0.0842	**0.0840**	0.0929	0.0795	**0.0862**
N_{14}	0.0852	0.0913	**0.0883**	0.1076	0.0939	**0.1007**	0.0964	0.0926	**0.0945**
N_{15}	0.0968	0.0913	**0.0941**	0.1166	0.0835	**0.1000**	0.1067	0.0874	**0.0970**
N_{16}	0.1219	0.1253	**0.1236**	0.1221	0.1313	**0.1267**	0.1220	0.1283	**0.1251**
MEAN	**0.1062**	**0.1019**		**0.1143**	**0.1045**		**0.1103**	**0.1032**	
	S.Em ±	**C.D at 5%**		**S.Em ±**	**C.D at 5%**		**S.Em ±**	**C.D at 5%**	
Varieties (V)	0.0009	**NS**		0.0027	**NS**		0.0017	**NS**	
Nutrients (N)	0.0040	**0.0114**		0.0050	**0.0142**		0.0033	**0.0094**	
N at same V	0.0057	**NS**		0.0071	**NS**		0.0047	**NS**	
Vat same or different N	0.0036	**NS**		0.0104	**NS**		0.0067	**NS**	

Varieties / Nutrients	RGR (g g^{-1} day) 90-at harvest								
	2015			2016			Pooled data		
Nutrients	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
N_1	0.0769	0.0872	**0.0820**	0.0761	0.0793	**0.0777**	0.0765	0.0833	**0.0799**
N_2	0.0791	0.0871	**0.0831**	0.0754	0.0807	**0.0781**	0.0772	0.0839	**0.0806**
N_3	0.0719	0.0634	**0.0676**	0.0732	0.0663	**0.0698**	0.0725	0.0649	**0.0687**
N_4	0.0870	0.0870	**0.0870**	0.0874	0.0880	**0.0877**	0.0872	0.0875	**0.0874**
N_5	0.0732	0.0665	**0.0699**	0.0715	0.0686	**0.0701**	0.0724	0.0675	**0.0700**
N_6	0.0838	0.0835	**0.0836**	0.0828	0.0868	**0.0848**	0.0833	0.0851	**0.0842**
N_7	0.0750	0.0734	**0.0742**	0.0747	0.0721	**0.0734**	0.0748	0.0727	**0.0738**
N_8	0.0780	0.0761	**0.0771**	0.0760	0.0727	**0.0743**	0.0770	0.0744	**0.0757**
N_9	0.0803	0.0746	**0.0775**	0.0792	0.0715	**0.0754**	0.0798	0.0731	**0.0764**
N_{10}	0.0790	0.0709	**0.0749**	0.0770	0.0729	**0.0750**	0.0780	0.0719	**0.0750**
N_{11}	0.0877	0.0869	**0.0873**	0.0909	0.0858	**0.0883**	0.0893	0.0864	**0.0878**
N_{12}	0.0808	0.0647	**0.0727**	0.0825	0.0630	**0.0727**	0.0816	0.0638	**0.0727**
N_{13}	0.0568	0.0567	**0.0567**	0.0591	0.0603	**0.0597**	0.0580	0.0585	**0.0582**
N_{14}	0.0784	0.0763	**0.0774**	0.0804	0.0760	**0.0782**	0.0794	0.0761	**0.0778**
N_{15}	0.0675	0.0701	**0.0688**	0.0838	0.0703	**0.0771**	0.0756	0.0702	**0.0729**
N_{16}	0.0851	0.0828	**0.0840**	0.0844	0.0861	**0.0853**	0.0848	0.0845	**0.0846**
MEAN	**0.0775**	**0.0754**		**0.0784**	**0.0750**		**0.0780**	**0.0752**	
	S.Em ±	**C.D at 5%**		**S.Em ±**	**C.D at 5%**		**S.Em ±**	**C.D at 5%**	
Varieties (V)	0.0014	**NS**		0.0010	**NS**		0.0011	**NS**	
Nutrients (N)	0.0038	**0.0107**		0.0026	**0.0073**		0.0029	**0.0081**	
N at same V	0.0054	**NS**		0.0037	**NS**		0.0040	**NS**	
Vat same or different N	0.0055	**NS**		0.0040	**NS**		0.0042	**NS**	

Varieties / Nutrients	Seed yield (q ha^{-1})								
	2015			2016			Pooled data		
Nutrients	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
N_1	12.05	9.43	**10.74**	12.93	9.62	**11.27**	12.49	9.52	**11.01**
N_2	12.51	9.49	**11.00**	13.22	9.80	**11.51**	12.86	9.65	**11.26**
N_3	11.79	11.85	**11.82**	12.43	12.14	**12.28**	12.11	11.99	**12.05**
N_4	14.84	14.86	**14.85**	15.55	15.22	**15.39**	15.19	15.04	**15.12**
N_5	10.56	10.49	**10.53**	10.89	10.58	**10.73**	10.72	10.54	**10.63**
N_6	14.87	14.81	**14.84**	15.29	14.34	**14.82**	15.08	14.57	**14.83**
N_7	10.33	9.00	**9.66**	10.80	9.14	**9.97**	10.56	9.07	**9.82**
N_8	10.14	9.38	**9.76**	10.29	8.62	**9.45**	10.21	9.00	**9.61**
N_9	10.10	9.16	**9.63**	10.03	9.37	**9.70**	10.06	9.27	**9.67**
N_{10}	10.36	9.50	**9.93**	10.18	9.47	**9.82**	10.27	9.49	**9.88**
N_{11}	15.34	15.22	**15.28**	15.66	15.53	**15.59**	15.50	15.37	**15.43**
N_{12}	12.68	9.56	**11.12**	12.67	9.54	**11.10**	12.67	9.55	**11.11**
N_{13}	9.95	8.37	**9.16**	9.96	8.71	**9.33**	9.95	8.54	**9.25**
N_{14}	10.05	9.58	**9.82**	10.03	9.83	**9.93**	10.04	9.70	**9.87**
N_{15}	14.65	10.88	**12.77**	12.70	11.18	**11.94**	13.68	11.03	**12.35**
N_{16}	15.17	14.78	**14.97**	15.47	14.17	**14.82**	15.32	14.48	**14.90**
MEAN	**12.21**	**11.02**		**12.38**	**11.08**		**12.30**	**11.05**	
	S.Em ±	**C.D at 5%**		**S.Em ±**	**C.D at 5%**		**S.Em ±**	**C.D at 5%**	
Varieties (V)	0.16	**0.49**		0.08	**0.24**		0.09	**0.29**	
Nutrients (N)	0.36	**1.04**		0.35	**1.00**		0.28	**0.79**	
N at same V	0.51	**1.47**		0.50	**1.41**		0.39	**1.12**	
Vat same or different N	0.63	**1.81**		0.33	**0.94**		0.38	**1.07**	

In INM effect significantly higher seed yield (15.43 q ha^{-1}) was recorded in supplied of N_{11} (75 % RD of FYM + 75% of RD NPK + *Azospirillum* + *PSB* + $ZnSO_4$ + $FeSO_4$), which was on par with N_4 (15.12 q ha^{-1}), N_{16} (14.90 q ha^{-1}), N_6 (14.83 q ha^{-1}). The lower seed yield (9.87q ha^{-1}) The increased seed yield consequence with application of balanced nutrient RD of FYM 75 % + RD of NPK micro nutrients mixed with bio fertilizers like *azospirillum* mechanism through phosphate dissolution and in the biosynthesis of bio-active in soil. The biofertilizers help in fixation of atmospheric nitrogen, better root proliferation, better availability and absorption of nutrients by the plants, which might have resulted in better growth in plant further N P K nutrients available form would attributed to more uptake of nutrients in faster rate in plant, *PSB* helps in reducing phosphorus fixation by its chelating effect and also solubilized the fixed phosphorus accelerated increase in growth of parameters towards reproductive parameters with accelerating tillers, dry matter production and increase towards yield attributing characters *viz*. number of seeds per spike and more, ultimately all these growth and reproductive yield attributes helped to increase seed yield, Similar findings observed by Repsiene (2001), Yadav *et al.*, (2003), Nadim *et al.*, (2011), Singh *et al.*, (2011), Tripati *et al.*, (2013), Choudhary *et al.*, (2014), Nadukeri *et al.*, (2014) and Shivran *et al.*, (2015).

Interaction effect

The interaction effect at harvest significantly higher dry matter production (9.30q ha^{-1}) was recorded with V_1 supplied with N_{11} (75 % RD of FYM + 75 % RD of NPK + *Azospirillum* + *PSB* + $ZnSO_4$ + $FeSO_4$) which was on par with V_1N_{11} (9.23 q ha^{-1}), V_1N_{16} (9.21 q ha^{-1}), V_1N_{16} (9.16) and V_1N_4 (9.13). However the lower dry matter production (8.18q ha^{-1}) was recorded with V_2N_{13} during in pooled data this might be due to the more tiller production and LAI which helps for conversion of accumulation of dry matter in different parts of plants which was achieved only with the development of growth parameters mainly plant height and number of leaves, LAI, germination per cent and number of tillers (tillering capacity of plants). Which also enhanced the biosynthesis of photosynthetic pigments by creating favourable cellular environment and providing nutrients for better growth; leading to carbohydrate translocation towards reproductive parts later translates to increase in dry matter production (Keer *et al.*, 2015). However the influence of different varieties and integrated nutrient management were found to be non significant with respect LAI and CGR (g m^{-2} day^{-1}) and RGR (g $g^{-1}day^{-1}$) recorded during in pooled data.

Interaction effect significantly higher seed yield (15.50 q ha^{-1}) was recorded in Vallabh Isabgol-1 supplied of N_{11} (75 % RD of FYM + 75% of RD NPK + *Azospirillum* + *PSB* + $ZnSO_4$ + $FeSO_4$), which was on par with V_1N_{16} (15.32 q ha^{-1}), V_1N_4 (15.29 q ha^{-1}) and V_1N_6 (15.08 q ha^{-1}). The lower seed yield (9.33 q ha^{-1}) was recorded in V_1N_{13} during pooled data This was attributed to genotypic variation of that variety and proper vegetative development by plants and differences in soil, agroclimatic condition then suitability of variety to that region and balanced application of 75 percentage of fertilizer doses with organics and micro nutrients application leads to plant to take adequate nutrition at optimum growth stage helps for plant more available NPK plant at faster rate, which leads to plant to absorb optimum nutrients, leads to increased in number of tillers and spikes per plant and spike length these findings leads to more longer period of vegetative growth parameters resulting in enhanced photosynthetic and metabolic activities then consequently enabling the plants to bear more spikes of longer size, and spike length with application organics along with *PSB* treatments, which in turn played an important role in rapid cell-division and elongation in the meristamatic regions, root development and proliferation of enhancing early and more flowering, results increase, in number spikes, spikelets per plant same findings observed by Hindiholi (2006), Kumar *et al.,* (2015) and Shivran *et al.,* (2016 b).

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