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Effect of integrated nitrogen management on the growth and yield of mustard [*Brassica juncea* L.]

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Abstract
A field experiment was conducted during the *rabi* season of 2017 on mustard crop (var. DHARA) at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Allahabad (U.P.). To study the effect of integrated nitrogen management on growth and yield of mustard. The experiment consisted of providing 80 kg nitrogen to mustard by supplying 50 kg nitrogen through urea and 30 kg nitrogen either through poultry manure or by farmyard manure or by vermicompost with and without *Azotobacter* seed inoculation, which was compared with 80 kg nitrogen supplied through urea alone. Hence, comprising of seven treatments, which were laid out in Randomized Block Design and replicated thrice. The result showed that Application of 50 kg nitrogen through urea + 30 kg nitrogen through poultry manure + *Azotobacter* (seed inoculation) gave higher growth attributes *viz.*, plant height (153.53 cm), plant dry weight (59.95 g), crop growth rate (2.64 g m^{-2} day^{-1}) and higher yield attributes *viz.*, number of siliqua $plant^{-1}$ (365.75), number of seeds $siliqua^{-1}$ (14.53), test weight (4.90 gm), seed yield (2.37 t ha^{-1}), stalk yield (6.62 t ha^{-1}) and consequently, harvest index (26.35).

Keywords: mustard, integrated nitrogen management, vermicompost, poultry manure, farm yard manure, azotobacter, growth and yield.

Introduction
Mustard (*Brassica juncea* L.) is the most important oilseed crop after groundnut accounting around 25 percent of total oilseed production. It is one of the important oilseed crops of Indo – Gangetic plains (Reddy S.R 2016). Oil seeds play the important role Indian economy next to food grains in terms of Area and Production. In India Mustard crop grown in about 5.76 million hectares with total production 6.82 million tonnes and average productivity of 1184 kg/ha. In Uttar pradesh mustard occupies the area 0.59 million hectares with total production 0.60cmillion tonnes and average productivity 1015 kg/ha (DE&S 2015-16). Nutrient management is one of the most important agronomic factor that affects the Indian mustard. But application of all the needed fertilizer through chemical fertilizers had deleterious effect of soil fertility, unsustainable yields. While integration with organic manures and bio – fertilizers would be able to maintain soil fertility and sustain crop productivity. Organic manures are also enhance the activity of soil in improving the physical and nutritional system of soil and also enhances the activity of soil microflora (Hadiyal *et al.*, 2017). Nitrogen is combined, to be the most important nutrient for the crop to metabolic activity and transformation of energy, chlorophyll and protein synthesis. Nitrogen also affects the uptake of other essential nutrients and it helps in the better for photosynthesis to reproductive parts which increases the seed: stover ratio.

Application of vermicompost and farm yard manure improves soil health by improving nutrient availability, water holding capacity (WHC), soil physical properties and microbial activity.

Poultry manure contains nutrient element that can support crop production and enhance the physical chemical properties of soil and improves lateral water movement. It contains higher nitrogen and phosphorous than other bulky organic manures and is a good source of production of elements rich fertilizer.

Bio-fertilizers have the potential to solubilize/ mobilize major nutrients such as nitrogen and phosphorus in addition to micro nutrients and thus act as nutrient flow regulator in nature. (Meena *et al.*, (2013) [3]. *Azotobacter* chroococum non–symbiotic nitrogen fixing agro – microbe having potential to fix combined quantities of atmospheric nitrogen in rizospere of non –legumes. *Azotobacter* synthesizes various growth hormones, antifungal substances and siderophores that favourably affect crop growth (Sunil *et al*., 2016) [8]. Keeping this in view, the present experiment was undertaken to study the effect of integrated nitrogen management on the growth and yield of mustard.

Materials and Methods

A field experiment was conducted during the *rabi* season of 2017 on mustard crop (var. DHARA) at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Allahabad (U.P.),which is located at $25^0$24 ˈ41.27" N latitude, $81^0$51'3.42" E longitude and 98 m altitude above mean sea level. The soil of experimental field was sandy loam having *p*H of 7.2,with 0.35% of organic carbon, available P is 18.2 kg/ha, available K is 241.8 kg/ha. The experiment consisted of 7 treatments with two levels of nitrogen i.e., (80 kg nitrogen through urea (control) and 50 kg nitrogen through urea) and 3 same levels of different organic manures with *Azotobacter* seed inoculation and without inoculation *viz.,* (30 kg nitrogen through vermicompost ; 30 kg nitrogen through poultry manure; 30 kg nitrogen through farm yard manure with *Azotobacter* (seed inoculation) and 30 kg nitrogen through vermicompost; 30kg nitrogen through poultry manure; 30 kg nitrogen through farm yard manure without *Azotobacter*, laid out in Randomized Block Design and replicated thrice. Mustard (var. DHARA) was sown 5th of November in 2017. Phosphorus and Potassium was applied as basal in full dose while, nitrogen was applied half dose as a basal at the time of sowing and remain half was applied at the span of flowering. Organic manures like farm yard manure, poultry manure and vermicompost were applied before sowing in furrows as per treatments as basal. The seeds was sown with seed rate of 7 kg/ha. The seeds were inoculated by *Azotobacter spp* as per treatment. The seeds were dried in shade and sown with depth 3 to 4 cm, with inter row spacing 45 cm. Required plant population was maintained by thinning out at 20 DAS. The crop matured in 110 days and was harvested 1st week of March. After harvesting, the data on yield attributes *viz*., siliqua plant^{-1}, Seeds siliqua^{-1}, test weight (g), seed yield (t ha $^{-1}$), stalk yield (t ha $^{-1}$), oil content (%) and harvest index (%) statistically analyzed and critical difference were calculated.

Table 1: Effect of Integrated Nitrogen Management on growth attributes of Mustard

Treatment	Plant height (cm)	Dry weight(g)	CGR(g m^{-2} day^{-1}) (40 – 60 DAS)
T_1: 80 kg N through urea (control)	148.06	48.78	2.11
T_2:50 kg N (U) + 30 kg N (VC) + *Azotobacter* (SI)	149.42	56.50	2.49
T_3:50 kg N (U) + 30 kg N (PM) + *Azotobacter* (SI)	153.53	59.95	2.64
T_4:50 kg N (U) + 30 kg N (FYM) + *Azotobacter* (SI)	147.70	42.68	1.82
T_5:50 kg N (U) +30 kg N (VC)	146.51	45.10	1.94
T_6:50 kg N (U) + 30 kg N (PM)	147.65	46.04	1.98
T_7:50 kg N (U) + 30 kg N (FYM)	140.77	41.63	1.77
F test	S	S	S
SED (±)	2.22	3.16	0.15
CD (P=0.05)	4.85	6.89	0.34

*Si –Seed Inoculation, Vc- Vermicompost, Fym- Farm Yard Manure, Pm-Poultry Manure

Table 2: Effect of Integrated Nitrogen Management on Yield attributes of Mustard

Treatment	Number of siliqua plant^{-1}	Number of seeds siliqua^{-1}	Test weight(g)	Seed yield (t ha^{-1})	Stalk yield (t ha^{-1})	Harvest index (%)
T_1: 80 kg N through urea (control)	351.97	14.47	4.86	2.28	6.38	26.33
T_2:50 kg N (U) + 30 kg N (VC) + *Azotobacter* (SI)	352.42	14.50	4.88	2.32	6.60	25.99
T_3:50 kg N (U) + 30 kg N (PM) + *Azotobacter* (SI)	365.75	14.53	4.90	2.37	6.62	26.35
T_4:50 kg N (U) + 30 kg N (FYM) + *Azotobacter* (SI)	320.82	14.07	4.64	2.04	6.45	24.01
T_5:50 kg N (U) +30 kg N (VC)	335.91	14.13	4.73	2.02	6.62	23.41
T_6:50 kg N (U) + 30 kg N (PM)	330.58	14.15	4.69	2.01	6.60	23.36
T_7:50 kg N (U) + 30 kg N (FYM)	318.70	14.01	4.64	1.99	6.16	24.44
F test	S	S	S	S	S	S
SED (±)	6.36	0.10	0.03	0.03	0.09	0.43
CD (P=0.05)	13.86	0.22	0.06	0.07	0.20	0.94

*Si –Seed Inoculation, Vc- Vermicompost, Fym- Farm Yard Manure, Pm-Poultry Manure

Results and Discussions

Growth attributes

Data pertaining to growth attributes are presented in Table 1, which revealed that the integrated nitrogen management in mustard, significantly increased the growth attributes like plant height (153.53 cm), dry matter accumulation (59.95 g), CGR (2.64 g m^{-2} day^{-1}) at 40 -60 DAS was observed statistically significant with treatment T3:50 kg N (U) + 30 kg N (PM) + *Azotobacter* (SI). These results are close conformity with Saini *et al.,* (2017) [1] and Lepcha *et al.,* (2015) [2]. Higher growth and dry matter accumulation of mustard may due to the higher concentration and fast releasing of poultry manure nutrients and *Azotobacter* application. It averts the leaching of nitrogen. These results are conformity with the findings of Sharma *et al.,* (2017) [7].

Yield attributes

As given in Table 2, the yield attributes *viz.*, number of siliqua plant $^{-1}$ (365.75), number of seeds siliqua $^{-1}$ (14.53), test weight (4.90 gm), are significantly higher with T3:50 kg N (U) + 30 kg N (PM) + *Azotobacter* (SI). These results are very close with the findings of Sharma *et al.,* (2017) [7]. The seed yield (2.37 t ha $^{-1}$), stalk yield (6.62 t ha $^{-1}$) and harvest index (26.35) was also found to be the highest in treatment T3:50 kg N (U) + 30 kg N (PM) + *Azotobacter* (SI).The similar result were obtained by Lepcha *et al.,* (2015) [2]. This increasing yield attributes could be the higher availability of nutrients under poultry manure and *Azotobacter* application. The increment in supply of essential nutrients to mustard, their availability, acquisition, mobilization and influx into the plant tissue increasing and thus improved yield components and finally the yield. These results are in conformity with those of Singh and Sinsinwar (2006) and Datta *et al.* (2009).

Conclusion

From the above findings, it can be concluded that the treatment T3: 50 kg N (U) + 30 kg N (PM) + *Azotobacter* (SI) was recorded significantly higher growth and yield attributes of mustard. These findings are based on one-season, so probably, for best results it may needed further trials.

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