JOURNAL OF PURE AND APPLIED MICROBIOLOGY, June 2016. Vol. **10**(2), p. 1637-1640

Effect of Fertility Levels and Cow Urine Application on the Performance of Indian Mustard [*Brassica juncea* (L.) Czernj. & Cosson]

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(Received: 17 January 2016; accepted: 01 March 2016)

An experiment was conducted during *rabi* season of 2013, under irrigated condition, at Varanasi to study the effect of fertility levels and cow urine application on growth and yield of Indian mustard [*Brassica juncea* (L.) Czernj. & Cosson]. Application of 100 % fertility level and 900 liter cow urine significantly increased the dry matter accumulation, physiological growth and yield attributes as well as yield of mustard in comparison to 50 % RDF and control respectively. Application of 100 % RDF produced 12.1 and 31.2 % higher seed yield than 75 % and 50 %RDF respectively. As regards the urine application, the increasing levels of urine application up to 900 l cow urine ha^{-1} enhanced the yield attributes as well as seed and stover yield. The investigation clearly indicated that under irrigated ecosystem of Varanasi no reduction in the recommended fertilizer dose to mustard is possible. Increasing levels of cow urine application up to 900 l ha^{-1} as basal dose markedly improved growth parameters, yield attributes as well as seed and stover yield of mustard. Fertilizer application at 120 Kg N + 60 KgP_2O_5 + 60 Kg K_2O +40 Kg S ha^{-1} and 900 l cow urine ha^{-1} produced maximum seed as well as stover yield and proved most remunerative.

Keywords: Growth, Indian mustard *(Brassica juncea* L.), SPAD, stover, yield and yield attributes**.**

Rapeseed-mustard is the leading winter season oilseed in India and it contributes significantly to the vegetable oil pool of the country. However, after reaching the plateau, productivity of oilseeds in general and rapeseed and mustard in particular is now slowing down coupled with decline in soil fertility. Low and imbalanced use of fertilizers is one of the major reasons for low productivity. It has been recognized that N, P and K fertilizers alone are not always sufficient to provide balanced nutrition for optimal yield and quality of mustard (Jain and Sharma, 2000). The exploitative agriculture particularly during post green revolution period in our country has brought down the fertility status of the soil to a level that even the application of fertilizers at recommended dose is unable to sustain the productivity of soil. Therefore, in order to sustain the productivity and promote the soil health, combined use of organic and chemical fertilizers is imperative (Gupta *et al.*, 2014).

Crop + dairy is the predominant farming system in the country practiced by over 70 % farm households. The abundant quantity of cattle excreta consisting of dung and urine is available. Though part of cattle dung is used as manure but major quantity of urine goes waste. However, cattle urine has a good manurial value and can be utilized as a bio-fertilizer. (Khanal *et al.*, 2011) .Cattle urine is a good source of nitrogen, phosphate, potassium, calcium, magnesium, chlorite and sulphate (Belie *et al.*, 2000). Application of cow urine has also been reported to correct the micronutrient deficiency, besides improving the soil structure and working as plant hormone. Therefore, it seems that cow urine under livestock based integrated farming system has a great

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potential for use as a bio- fertilizer to economize the crop production.

Keeping these facts in view, the present experiment was planned and carried out during winter season 2013 -14 at the research farm, Institute of Agricultural Sciences, B.H.U., Varanasi. The soil of the experimental field was clay loam, having 0.38% organic C and 7.8 pH. It was low in available N (138.48 kg ha^{-1}), medium in available P_2O_5 (23.31 kg ha^{-1}) and K (72.10 kg ha^{-1}).

MATERIALS AND METHODS

Experiment was laid out in split plot design with 3 replications. The main plot treatment consisted three fertility levels i.e. 50%, 75% and 100% RDF(120 kg N +60 kg P_2O_5+ 60 kg K_2O+ 40 kg S ha^{-1}), whereas, four levels of cow urine i.e. 0, 300, 600, 900 l ha^{-1} were allocated to sub-plots. To maintain the homogeneity, water @ 900,600,300 and 0 l ha^{-1} was added to the urine levels i.e. 0,300,600 and 900 l Ha^{-1}, respectively. So the total numbers of treatment combinations were twelve. Furrows were opened in each plot at a distance of 40 cm for sowing of mustard variety 'Pro agro 4001' sown at 5 kg /ha. Half of N and full doses of P and K were applied in furrows after mixing with moist soil. The sources of N, P, K and S were Urea, DAP, MOP and elemental sulphur, respectively. The rest half nitrogen was top dressed through urea at one month stage. Cow urine with or without water as per treatment was applied in furrows opened for sowing. Thinning of extra plants was done after 18 days of sowing at a distance of 15 cm to maintain proper plant population. All the agronomic operations were kept uniform in all the plots. Pendimethalin 30 EC @1 kg/ ha was applied as pre emergence spray. This was accompanied by one mechanical-cum-manual weeding at 4 week stage of the crop. One pre sown and two post sowing irrigation were applied to maintain optimum soil moisture for plant growth. Observations on the growth and yield attributes as well as yield of seed and stover were recorded as per the established norms.

RESULTS AND DISCUSSION

The increasing fertility levels up to 100 % RDF markedly influenced the growth parameters *viz.* plant height, leaf area index, leaf chlorophyll content in terms of SPAD value and dry matter production $plant^{-1}$ (Table 1). This supports the well established fact that combined application of nitrogen, phosphorus, potassium and sulphur in adequate quantity is beneficial for growth and development of mustard. (Athokpam, 2010).

As evident from the SPAD value (Table 1) higher fertility levels might have induced greater translocation of photosynthates from leaves *via* stem to sink i.e. siliqua and seeds. This resulted in bigger siliqua and more number of seed $siliqua^{-1}$ which on maturity became bold with higher test weight (Table 1). The better plant growth at higher fertility levels also helped the plants to bore higher number of siliqua on main shoot as well as siliquae $plant^{-1}$. Increasing levels of fertilizer application from 50 to 100 % RDF significantly increase the seed yield (Table 2). Fertilizer application at 100 % RDF recorded 31.2 % and 14.1 % higher seed yield over 50 % and 75 % RDF, respectively. The increase in yield due to application of nitrogen, phosphorus, potassium and sulphur in higher doses may be attributed to cumulative effect of increase in yield attributing characters. The results are in conformity with the findings of Tomar *et al.* (2005) and Ghimire and Bana (2009).

Marked effect of cow urine application was observed on growth attributing characters (Table 1). Application of 900 l ha^{-1} cow urine being at par ha^{-1} with 600 l ha^{-1} recorded significantly higher plant height and dry matter $plant^{-1}$ than control at 90 DAS. The growth attributing characters improved probably due to better supply of nutrients at higher rates of urine application as the chemical analysis of the cow urine applied in the present investigation showed to contain 0.978 % N, 0.0917 % P, 0.11 ppm K, 0.80 ppm Ca and 3.21 ppm Mg. Therefore more availability of N at higher rates of cow urine application might have favored protein synthesis and greater SPAD values (Table 1) indicate increased leaf chlorophyll content and thereby higher photosynthesis. Potassium, the other important constituent of cow urine (0.11 ppm) as an activator of enzymes regulates carbohydrate metabolism and protein synthesis; it also controls P^H, stomatal opening and membrane permeability. Besides this the different enzymes and hormones present in cow urine are also responsible for the better growth of plant (Vahanka *et al*. 2010).

All the yield attributing characters were

positively influenced by increasing levels of urine application particularly at 600 and 900 l ha^{-1}. This could be ascribed to the better growth parameters at higher rate of urine application. The results are in close conformity with the findings of Khanal *et al.* (2010) and Vahanka *et al.* (2010). As nitrogen is one of the major constituent of cow urine, its application at higher rate might have enhanced the process of tissue differentiation, cell multiplication, cell enlargement i.e. from somatic to reproductive phase, meristematic activity and development of floral primodia leading thereby to increased flowering and ultimately the fruit setting. As a result, higher siliqua $plant^{-1}$ was obtained with increasing levels of urine application up to highest level (900 l ha^{-1}). As nitrogen and potassium both are involved in protein synthesis and K helps in the translocation of photosynthates to sink, under adequate urine supply, there would have been greater translocation of photosynthates from source to sink leading thereby to production of bolder seeds with higher test weight. The favorable

Table 1. Effect of fertility and cow urine levels on growth and yield attributes of mustard

Treatments	Plant Height* (cm)	Dry matter/ plant* (g)	Leaf Chlorophyll content** (SPAD)	LAI**	Siliquae on main shoot	Siliquae / plant	Seeds $siliqua^{-1}$	Test weight (g)
Fertility levels								
50% RDF	128.8	50.1	40.1	3.10	37.7	130.3	6.58	3.78
75% RDF	136.1	62.3	43.6	3.52	42.5	133.7	8.17	4.19
100% RDF	139.8	68.3	44.8	3.70	48.0	136.7	9.50	4.53
S. Em+	1.96	1.26	0.36	0.08	0.57	0.75	0.34	0.09
C.D. 5%	7.69	4.95	1.41	0.32	2.3	2.9	1.35	0.37
Cow urine levels (l ha^{-1})								
0	130.2	55.9	41.2	3.10	40.5	130.9	7.11	3.97
300	134.0	57.9	42.1	3.37	41.6	133.3	8.00	4.05
600	136.9	62.9	43.6	3.60	43.6	134.7	8.33	4.24
900	138.6	64.4	44.5	3.69	45.2	135.4	8.88	4.40
S. Em+	1.16	1.40	0.48	0.08	0.39	0.66	0.33	0.08
C.D. 5%	3.44	4.17	1.42	0.25	1.2	2.0	0.97	0.23

* At 90DAS **At 60 DAS

Table 2. Effect of fertility and cow urine levels on yield and economics of mustard

Treatment	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (%)	Gross return ($Rs.ha^{-1}$)	Cost of cultivation ($Rs.ha^{-1}$)	Net Return ($Rs.ha^{-1}$)	B:C ratio
Fertility levels							
50% RDF	930	2709	25.6	39924	25286	14638	1.577
75% RDF	1069	2970	26.6	45749	28213	17535	1.621
100% RDF	1220	3270	27.4	52078	31156	20922	1.671
S. Em+	34.0	111.6	0.90	1388	-	1388	0.052
C.D. 5%	133	438.3	NS	5449	-	5499	NS
Cow urine levels (l ha^{-1})							
0	996	2710	26.8	42533	27255	15277	1.555
300	1052	2803	27.3	44889	27897	16991	1.608
600	1115	3091	26.5	47705	28539	19166	1.669
900	1130	3327	25.4	48541	29189	19360	1.660
S. Em+	12.7	52.0	0.43	504	-	504	0.019
C.D. 5%	37.6	155.1	1.3	1497	-	1497	0.055

effect of urine application on yield attributing characters was reflected on seed yield that increased markedly with increasing levels of urine application up to 900 l ha^{-1} (Table-2). However the difference between 600 and 900 l ha^{-1} not significant. The results are in agreement with the findings of Mohanty *et al.* 2014. Increasing levels of urine application from 0 to 900 l ha^{-1} favorably improved the stover yield that could be attributed to the better plant growth at higher levels of urine application (Saunders, 1987). The harvest index was slightly improved with the application of 300 l urine ha^{-1} but thereafter it declined with increasing levels of urine application up to highest level. This shows that urine application at 300 l ha^{-1} was more efficiently utilized towards seed production.

Economics

Increasing levels of fertilizer application from 50 to 100 % RDF significantly enhanced the gross return. Net returns also followed the similar trend but the difference was significant only between 50 % and 100 % RDF. Benefit cost ratio though improved with each increment of fertilizer level but the differences could not turn significant.

This clearly shows that curtailment of recommended fertilizer dose to mustard is not possible. Increasing levels of cow urine application from 0 to 600 l ha^{-1} markedly improved gross return, net return and benefit cost ratio. However, beyond 600 l urine ha^{-1}, the gross return and net return continued to increase but could not touch the level of significance suggesting that maximum net return could be realized with the cow urine application of 900 l ha^{-1}.

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