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Effect of organic and inorganic sources of nutrients on growth and yield attributing characters of mustard crop (*Brassica juncea* L.)

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Abstract
A field experiment was conducted to study the effect of organic and inorganic sources of nutrients on yield, quality and nutrients uptake by mustard (*Brassica juncea* L.) variety Pusa Mustard 30 (LES-43) at Crop Research Centre *and* Sardar Vallabhbhai Patel University of Agriculture Technology, Meerut during *rabi* season, 2016-17. The experimental results revealed that maximum growth parameters (plant height, branches plant^{-1}, dry matter accumulation and leaf area index), yield attributes (siliqua length, siliqua plant^{-1}, seeds siliqua^{-1} and test weight), yield (grain and stover), nutrient uptake (N,P, K and S) by grain and stover and available soil nutrient (N, P, K and S),were recorded with application of 50% RDF+ FYM 6 t/ha + Vermicompost 2 t/ha+ bio-fertilizer higher than the rest of the treatments. The increment in seed yield with application of 50% RDF+ FYM 6 t/ha + Vermicompost 2 t ha^{-1} + Bio-fertilizers was 168.35% over control. Maximum gross return, net return were recorded with the application of 50% RDF+ FYM 6 t ha^{-1} + Vermicompost 2 ha^{-1} + Bio-fertilizers, however B: C ratio was lower than the use of RDF only but in application of FYM and vermicompost improved the physio chemical properties of soil which may improved the sustainability of production system.

Keywords: Nutrient management, Indian mustard, growth and yield

Introduction

India is the third largest rapeseed-mustard producer in the world after China and Canada. This crop accounts for nearly one-third of the oil produced in India, making it the country's key edible oilseed crop (Kumar *et al.,* 2007) [10].

In India, it is third most important edible oilseed crop after soyabean and groundnut sharing 27.8% in the India's oilseed economy. The global production of mustard and its oil is around 38-42 mt & 12-14 mt respectively. India contributes 28.3% and 12.0% in world acreage and production. India produces around 6.9 mt of rapeseed-mustard next to China (11-12 mt) and EU (10-13 mt) with significant contribution in world mustard industry (Anonymous, 2014) [1]

In India Uttar Pradesh is the second largest producer of mustard after Rajasthan. The mustard grown in the Uttar Pradesh is 7, 85,000 ha with production about 8, 48,000 tonnes and productivity 1080 kg ha^{-1} area as per government estimates 2016-17 [16].

By 2050, India needs to produce 17.84 mt of vegetable oils for its nutritional fat requirement of projected 1685 million populations. This target is difficult to achieve at current status of technology and resources management in Indian agriculture (Hegde, 2012) [5] Thus, enhancing the productivity of oilseeds is imperative for self-reliance. India holds 11.3 % of world's arable land and only 4% of the water resources to feed 16% of human population and 18% of animal population of the world. India oilseed scenario recently presented a picture of virtual stagnation. The technology mission on oilseed (TMO) launched by government of India in 1986 has impacted to overall production of oilseed significantly. The transformation in mustard scenario is commonly known as "Yellow–Revolution" the quantum jump in production of mustard is to be attributed to the development of improved technology.

Mustard (*Brassica juncea* L.) is coming up as a new crop in many parts of the country with increase in irrigation facilities. However, productivity of mustard and other oilseed crops is low. Oil seed production often suffers from a high degree of variation in annual production owing to their predominant cultivation under imbalance nutrient situation. The situation is further handicapped by input starved conditions with poor crop management.

Oilseeds are energy rich crops and obviously the requirement of major nutrient is very high. Improving efficiency and factor productivity under complexities of diminishing quantity response and increasing eco-awareness is critical for sustainable oilseed production.

Identification of the critical inputs to enhance the mustard production is need of hour. Apart from improved varieties and judicious irrigation, use of balanced fertilizers is critical for realizing higher yield. Indian soils are becoming deficient in N, P, and K along with S due to intensive cultivation and use of high analysis fertilizers, under such situation organic manures can be exploited to boost the soil health condition vis-à-vis production of crops and to improve fertilizer use efficiency.

Nitrogen is the most important nutrient, which determines the growth of the mustard crop and increases the amount of protein and yield. Phosphorus and potash are known to be efficiently utilized in the presence of nitrogen. It promotes flowering, setting of siliqua and increase the size of siliqua and yield (Singh and Meena, 2004) [13].

Judicious use of nutrients is very important as our country is importing most of the fertilizers from aboard. Under present situation, focus on nutrient management on mustard needs to be changed by integration with other option. The use of total organic or inorganic nutrient sources has some limitations (Kandpal, 2001) [8]. Balanced combination of FYM, biofertilizers and chemical fertilizers facilitate profitable and sustainable production (Singh and Sinsinwar, 2006) [14]. The integrated plant nutrient management is maintenance or adjustment of soil fertility and plant nutrient supply to an optimum level for sustaining desired crop production through optimization of benefits from all possible sources of plant nutrients. Various sources of plant nutrients such as organic manures, fertilizers and bio-fertilizers were even though applied in mustard in an integrated manner (Chand, 2007) [2].

Fertilizers are very important sources of plant nutrients for increasing agricultural production. The mineral fertilizer could supply one or two nutrients but integrated use of macro- and micro-nutrient fertilizers and organic residues would provide N, P, K, S, Zn, Fe and B to plant and soil and resist occurrence of multiple nutrient deficiencies. The role of organic fertilizers in plant nutrition is now attracting the attention of agriculturists and soil scientists throughout the world. If sufficient quantity of organic manures is added along with mineral fertilizers then perhaps there would be no need of adding micronutrients *(Prasad et al., 1999)* [12].

Now – a- days a variety of locally available organic manure are available. Their chemical decomposition as well as break down is variableThe pH of FYM is 7.50, total NPK is 0.94, 0.56, 0.72%, it improves the chemical and biological conditions of soil increasing cation exchange capacity and providing various, vitamins, hormones and organic acids which are very important for soil aggregation and beneficial micro-organism which involved in various bio-chemical process and release of nutrients (Chandra, 2005) [3].

Materials and Methods

The experiment was conducted during *Rabi* season of 2016-17 in the field at the Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.). The experiment consists of fourteen treatments viz., (T_1) *Control*, (T_2) Bio-fertilizers (Azotobactor + PSB), (T_3) 100% RDF (120:60:60: 40, N:P:K:S, kg ha^{-1}), (T_4) 100% RDF + Bio-fertilizers, (T_5) 75% RDF + FYM 6 t ha^{-1}, (T_6) 75% RDF + FYM 6 t ha^{-1} + Bio-fertilizers, (T_7) 75% RDF + Vermicompost 2 t ha^{-1}, (T_8) 75% RDF + Vermicompost 2 t ha^{-1} + Bio-fertilizers, (T_9) 50% RDF + FYM 12 t ha^{-1}, (T_{10}) 50% RDF + FYM 12 t ha^{-1} + Bio-fertilizers, (T_{11}) 50% RDF + Vermicompost 4 t ha^{-1} (T_{12}) 50% RDF + Vermicompost 4 t ha^{-1} + Bio-fertilizers. (T_{13}) 50% RDF + FYM 6 t ha^{-1} + Vermicompost 2 t ha^{-1} and (T_{14}) 50% RDF + FYM 6 t ha^{-1} + Vermicompost 2 t ha^{-1} + Bio-fertilizers. The experiment was laid out in randomized block design with three replications, P, K and S per plot was applied in the reported treatment from urea (46% N), di ammonium phosphate (46%P2O5), muriate of potash (60% K2O) and bentonite sulphur (90% S). The half dose of nitrogen and full dose of phosphorus, potassium and sulphur, was applied as basal and rest half amount of nitrogen was applied as top dressing at 35 DAS. The various plant growth studies were carried out at 30, 60, 90 DAS and finally at harvest as per procedure are given below. The various plant growth studies were carried out at 30, 60, 90 DAS and finally at harvest as per procedure are given below. Five plants selected randomly from each plot were tagged. The height was measured in cm with the help of meter scale from the base of the plant to the top of the plant and mean values were presented. Five plants uprooted plant for dry matter accumulation were also used. The total number of primary and secondary branches of plant was counted and mean values per plant have been presented. Plants were uprooted from per plot at 30, 60, 90 DAS and at harvesting. The plants were sun dried separately and then oven dried at 72 ± 0.50C till the constant weight is obtained. The dry matter accumulation was expressed in g plant^{-1}

Soil and plant analysis

The processed plant samples were analyzed by micro-Kjeldahl method (Jackson, 1967) [6] to determine nitrogen content. Wet digestion (di-acid) method (Jackson, 1973) [7] was used for preparation of aliquot to determine P, K and S content in plant. The protein content (percent) was determined „as is‟ via the standard Kjeldahl method using the nitrogen protein conversion factor of 6.25, the accepted standard. (Kjeldahl, 1883) [9] were as follows: Grain protein content (%) = Nitrogen content (%) X 6.25.Seed samples were collected from each number of plot and analysed for oil content (%) in seeds with the help of Soxhlet apparatus method taking petroleum ether as a solvent.

Soil Analysis

Soil samples were collected from 0-15 cm. depth from each plot. These samples were processed and analyzed for various physico-chemical properties in the laboratory of department of soil science, in Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut. Available nitrogen in soil was determined by alkaline potassium permanganate method (Subbiah and Asija, 1956) [16]. Available phosphorus was determined by Ascorbic acid method (Olsen *et al.,* 1954) [11]. Available K in the soil was determined by Extraction Method (Hanway and Heidal, 1952). Available sulphur was determined by the turbidimetric procedure (Williams, C.H. and Steinberg, A. 1969) [17].

Result and Discussion

Growth and Yield attributes

Increase in plant height with organic inorganic sources might be due to higher nutrient supply, rapid conversion of carbohydrates in to protein which in turn elaborated in to protoplasm. The highest plant heights of 30,60,90 and at harvest DAS were recorded in T14 (50% RDF + FYM 6 t ha^{-1}

+ Vermicompost 2 t ha^{-1} + Bio-fertilizers) crop growth respectively. However the shortest plant height was recorded in control plot (T1). Nitrogen increased in size of cell, which expressed morphologically increased in plant height. The yield of *Brassica species* is a function of yield attributes like length of siliqua, number of siliquae $plant^{-1,}$ number of seeds siliqua-1, 1000-seed weight. For these again a good mustard crop is required, which in turn depends upon optimum growth of photosynthetic organs, translocation of nutrients and photosynthesis to developing plant parts and finally larger frame to accommodate more number of yield attributes. The length of siliqua, number of siliquae $plant^{-1}$, number of seeds $siliqua^{-1}$ and 1000-seed weight, g respectively found in T14 (50% RDF + FYM 6 t ha^{-1} + Vermicompost 2 t ha^{-1} + Bio-fertilizers). However the minimum number recorded in control plot (T1) which was significantly lower than other treatments at all the stages. The balanced nutrient management practices contributed to a great extent influencing the seed yield of mustard. The seed yield increased with the increasing fertility levels and recorded highest grain, Stover and biological yield 21.20, 74.89 and 96.09, q ha^{-1} respectively in T14, where 50% RDF + FYM 6 t ha^{-1} + Vermicompost 2 t ha^{-1} + Bio-fertilizers was applied. However the minimum yield was recorded in control plot (T1) which was significantly lower than other treatments.

Table 1: Effect of organic and inorganic sources of nutrient management on plant height (cm) of mustard at different growth stages

Treatment	30 DAS	60 DAS	90 DAS	At harvest
Control	15.93	83.73	124.86	129.20
Bio-fertilizers (Azotobactor + PSB)	17.93	92.40	156.86	158.00
100% RDF (120:60:60:40,N:P:K:S,kg ha^{-1})	22.46	108.00	163.40	166.70
100% RDF + Bio-fertilizers	22.89	113.53	172.66	176.30
75% RDF + FYM 6 t ha^{-1}	22.20	110.26	170.20	174.50
75% RDF + FYM 6 t ha^{-1} + Bio-fertilizers	23.53	120.50	177.40	179.20
75% RDF + Vermicompost 2 t ha^{-1}	23.30	117.00	171.80	173.50
75% RDF + Vermicompost 2 t ha^{-1} + Bio-fertilizers	24.33	119.70	182.33	183.80
50% RDF + FYM 12 t ha^{-1}	23.73	117.93	180.66	182.80
50% RDF + FYM 12 t ha^{-1} + Bio-fertilizers	26.80	125.60	188.50	192.20
50% RDF + Vermicompost 4 t ha^{-1}	22.53	122.93	178.53	183.20
50% RDF + Vermicompost 4 t ha^{-1} + Bio-fertilizers	28.93	126.06	187.13	189.50
50% RDF + FYM 6 t ha^{-1}+Vermicompost 2 t ha^{-1}	30.56	130.40	189.73	195.40
50% RDF+FYM 6 t ha^{-1} +Vermicompost 2 t ha^{-1}+ Bio-fertilizers	31.50	134.33	193.50	198.66
SEm ±	0.51	1.47	1.48	1.28
CD (P= 0.05)	1.45	4.19	4.21	3.66

Table 2: Effect of organic and inorganic sources of nutrient management on length of siliqua (cm), siliqua $plant^{-1}$, seed $siliqua^{-1}$ and 1000- seed weight of mustard

Treatment	Length of siliqua (cm)	Siliqua $plant^{-1}$	Seed $siliqua^{-1}$	1000- seed weight (g)
Control	4.23	175.50	7.60	4.15
Bio-fertilizers (Azotobactor + PSB)	4.56	204.50	7.80	4.25
100% RDF (120:60:60:40,N:P:K:S,kg ha^{-1})	4.85	270.5	9.80	4.60
100% RDF + Bio-fertilizers	5.52	290.50	10.00	4.69
75% RDF + FYM 6 t ha^{-1}	5.12	285.50	9.90	4.65
75% RDF + FYM 6 t/ha + Bio-fertilizers	5.36	295.50	10.10	4.80
75% RDF + Vermicompost 2 t ha^{-1}	5.75	292.10	9.95	4.75
75% RDF +Vermicompost 2 t ha^{-1} + Bio-fertilizers	5.85	296.50	10.15	4.90
50% RDF + FYM 12 t ha^{-1}	5.55	275.89	9.91	4.65
50% RDF + FYM 12 t ha^{-1} + Bio-fertilizers	5.82	285.75	10.11	4.83
50% RDF + Vermicompost 4 t ha^{-1}	5.65	282.50	9.96	4.69
50% RDF + Vermicompost 4 t ha^{-1} + Bio-fertilizers	5.90	309.80	10.25	4.94
50% RDF + FYM 6 t ha^{-1} + Vermicompost 2 t ha^{-1}	6.06	315.59	10.35	5.15
50% RDF + FYM 6 t ha^{-1} + Vermicompost 2 t ha^{-1}+ Bio-fertilizers	6.20	319.70	11.40	5.25
SEm ±	0.11	7.56	0.36	0.11
CD (P= 0.05)	0.32	22.57	1.06	0.30

Table 3: Effect of organic and inorganic sources of nutrient management on seed, stover, biological yield (q ha^{-1}) of mustard

Treatment	Seed Yield (q ha^{-1})	Stover yield (q ha^{-1})	Biological yield (q ha^{-1})
Control	7.90	26.69	34.59
Bio-fertilizers (Azotobactor + PSB)	9.15	33.80	42.98
100% RDF (120:60:60:40,N:P:K:S,kg ha^{-1})	17.60	62.25	79.85
100% RDF + Bio-fertilizers	18.72	69.75	88.47
75% RDF + FYM 6 t ha^{-1}	17.95	63.65	81.60
75% RDF + FYM 6 t/ha + Bio-fertilizers	18.45	68.33	86.78
75% RDF + Vermicompost 2 t ha^{-1}	18.32	68.05	86.37
75% RDF +Vermicompost 2 t ha^{-1} + Bio-fertilizers	18.95	70.20	89.15
50% RDF + FYM 12 t ha^{-1}	17.92	63.45	81.37
50% RDF + FYM 12 t ha^{-1} + Bio-fertilizers	18.85	70.05	88.90
50% RDF + Vermicompost 4 t ha^{-1}	18.65	69.65	88.30

50% RDF + Vermicompost 4 t ha^{-1} + Bio-fertilizers	19.92	72.65	92.57
50% RDF + FYM 6 t ha^{-1} + Vermicompost 2 t ha^{-1}	20.40	73.56	93.96
50% RDF + FYM 6 t ha^{-1} +Vermicompost 2 t ha^{-1} + Bio-fertilizers	21.20	74.89	96.09
SEm ±	*0.67*	*1.55*	*2.25*
CD (P= 0.05)	*1.96*	*4.50*	*6.66*

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