Journal of Medicinal Plants Studies
www.PlantsJournal.com

ISSN (E): 2320-3862
ISSN (P): 2394-0530
NAAS Rating 2017: 3.53
JMPS 2017; 5(6): 57-61

Received: 12-09-2017
Accepted: 20-10-2017

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Yield, yield economics and nutrient uptake of Indian mustard (*Brassica juncea*) as impacted by integrated nutrient management and sowing geometry

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Abstract
Oilseed crops involve a significant job in our cultivating framework after food grains. India claims a conspicuous situation in the creation of mustard everywhere on the world. As the trial works continue it gets critical to comprehend different extensions in late planted Indian mustard *Brassica juncea* (L.) Czern and Coss, there seems an incredible chance of demonstrating Mustard as a great option. This paper reviews such modules incorporating the treatments of INM and sowing methods which impact the yield and economics of Mustard. The incorporated impact of FYM, fertilizer, vermicompost, composts, PSB, Azotobacter, Sulfur and so forth are concentrated in different exploration work done already and every one of them stringently suggested that for better quality and great grain and oil creation in mustard INM is essentially advantageous than typical agricultural practices and brings about critical expansion in development characters, high return, better oil quality, expansion in nutrient uptake which prompts higher pay of yield through mustard. Regardless of the soil conditions or other unfavorable impacts, at whatever point INM was received in mustard, it generally improved the physical and chemical properties of soil, improves soil well-being. Better nutrient uptake because of INM prompts great quality oil and protein creation in mustard. Utilization of suggested portion of fertilizers spikes the NPK uptake of the plants and great leftover impact prompts positive conditions and fertilizer replacement for succeeding harvest.

Keywords: INM, nutrient uptake, PSB, Indian mustard

Introduction

Oilseeds share about 14.1 percent of the aggregate trimmed region in India are close to cereals and play a significant job in agrarian economy of the country. Rapeseed-Mustard (*Brassica species*) is a significant gathering of harvests among oilseeds and involves Indian mustard, Indian assault, oilseed assault, Ethiopian mustard, taramira, and dark mustard. India positions first in region and second in creation of rapeseed-mustard after China on the planet.

Rapeseed-mustard gathering of yields represent 3% of absolute trimmed region in India and contribute 28.6 percent to absolute creation of oilseeds (Mukherjee, 2015). India contributes 12% to world's absolute creation of rapeseed-mustard. Yield should be ventured up fundamentally to build the creation of oilseeds to meet the developing interest. Among various harvests of rapeseed-mustard, Indian mustard is the most adjusted yield in the Indo-Gangetic zones (Singh *et al*., 2009). The capacity of a rapeseed-mustard plant depends incredibly upon plant thickness per unit region and soil richness status (Shekhawat *et al*., 2012). Planting calculation influences overhang design of harvests and impacts light capture attempt what's more, radiation use and subsequently development and usefulness.

A uniform distribution of plants for each unit region is an essential for yield acknowledgment (Mukherjee, 2014) as it impacts use of supplements, dampness and concealment of weeds. In more extensive line dividing, sun based radiation falling inside the lines gets squandered especially during the beginning phases of yield development though in nearer column dividing upper piece of the harvest covering might be well over the light immersion limit yet the lower leaves stay kept from light and in this manner have poor photosynthesis. At present extremely inadequate data is accessible for development practices of Indian mustard in new alluvial locale of West Bengal which addresses flood plain regions along the stream courses. It has more sand and residue than soil.

The current examination was, subsequently, done to improve the supplement necessities and planting calculation for Indian mustard filled in new alluvial zone.

At the point when natural compost (FYM @ 10-15 ton/ha) with 100% suggested NPK portion is applied, there is a high usefulness maintenance which is seen in major trimming frameworks, however soil condition is additionally thought of. Successful utilization of Farm Yard Manure (FYM), different bio-composts (Azotobacter, PSB) with perfect measure of other manures can work with productive and feasible creation and are found to improve physical, synthetic and organic soil properties (Shroff and Devasthali, 1992, Singh *et al*., 2017). Moreover (Meena *et al*., 2014) found that soil quality moreover improved with the utilization of natural excrements like FYM, leaf fertilizer and vermicompost. Utilization of farm yard compost (FYM), vermicompost (VC) and bio-manures like Azotobacter in reasonable blend with manures can work with beneficial results, feasible creation and are found to improve physical, synthetic and organic soil properties (Shroff and Devasthali, 1992, Singh *et al*., 2018a). To upgrade efficiency of rapeseed- mustard coordinated utilization of natural and inorganic composts not just guarantees accessibility of all the fundamental plant supplements yet in addition improves the soil compound, natural properties and harvest usefulness (Thakur *et al*., 2009, Meena *et al*., 2015). To keep up the soil richness and usefulness, utilization of natural and inorganic assets in the perfect sum is profoundly compelling. Henceforth, a wise utilization of natural and inorganic wellspring of supplements can prompt upkeep of soil health and usefulness. This paper will summarize the different designs under the utilization of coordinated nutrient management in mustard momentarily.

Nitrogen (N) is the most significant supplement, and being a constituent of cellular material and protein, it is associated with a few metabolic cycles that emphatically impact development, usefulness and nature of crops. The N compost application represents critical harvest creation cost. Rapeseed-mustard gathering of crops have moderately appeal for N than numerous different yields inferable from bigger N content in seeds and plant tissues (Malagoli *et al*., 2005) [10]. Yield expansions in Indian mustard at different areas in India have been accounted for with utilization of N as high as 150 kg/ha or more (Singh *et al*., 2008) [17]. Brassicas are known to eliminate higher measure of N until blossoming with generally lower sum taken up during conceptive development stage (Bhari *et al*., 2000) [2]. Helpless movement of N from vegetative parts to seed during conceptive development brings about low nitrogen use productivity. Since N manures are exorbitant, helpless NUE is of incredible concern and subsequently, endeavors are expected to improve the commitment of applied N to creation of grain and this methodology will lessen the ecological and creation costs in agribusiness. Indian mustard is especially being profound attached and can use the soil dampness and supplement lower layers of the soil. In this manner, they generally become under rainfed condition at lingering soil dampness on negligible and sub minimal land. Be that as it may, crop under such condition result in poor yield. A few agronomical controls are expected to tackle the most extreme yield potential relying upon the climatic and asset the executives. Water system also, fruitfulness levels impact by and large of development, yield credits and yield (Bharati *et al*., 2003) [1]. Irrigation necessity of mustard fluctuates with crop conditions, dampness capacity in the soil profile and prevailing climate state of the space. Nutrient supply is likewise most significant boundary affecting the development and usefulness of mustard. Keeping in see the above realities the test was led on "development and usefulness of half breed mustard as affected by irrigation and the nitrogen supply".

Methodology

The experiment contained 9 treatment permutations, which involved 3 treatments [I_1 (IW/CPE ratio=0.8), I_2 (IW/CPE ratio=1.0), I_3 (IW/CPE ratio=1.2)] in main plot and 3 treatments [N_1 (40 kg N ha^{-1}), N_2 (80 kg N ha^{-1}), N_3 (120 kg N ha^{-1})] in sub plots, spread out in split plot plan with three replications. The fertilizer supplements were provided through urea, diammonium phosphate (DAP) and muriate of potash (MOP). Half portion of nitrogen and full portion of phosphorus and potassium according to treatment were applied as basal and remaining portion of nitrogen was applied from the first irrigation. The hybrid mustard cultivar PAN 70 was planted at 30 x 15 cm with a seed rate of 4-5 kg/ha separated during the second seven day stretch of November. Neglected the standard methods also, perceptions were recorded on development, yield ascribes and yield. Plant height at various phases of yield development were recorded by five arbitrarily chosen plants from lines and measure the ground to top leaf of plant by centimeter scale and arrived at the midpoint of them in cm. five plants for every plot were cut from the ground level from examining line at 30, 60, 90 DAS and gather stage. Those plants were first air-dried for 2-3 days following by oven dried at 60-65°C for 48 hours and dry weight was recorded in g plant^{-1}. The mean yield development rate was worked out with the following equation (Watson *et al*., 1952)

$$\text{CGR} = \left(\frac{W2-W1}{T2-T1}\right)\left(\frac{1}{S}\right)$$

Where

W_1 and W_2 are dry weight (g) of plants at time

T_1 and T_2, respectively

T_2- T_1 is the interval of time in days

S is land area (m^2) occupied by plants

At harvest, the quantity of siliqua of principle shoot, essential, optional and tertiary parts of every one of the five labeled plants was tallied independently, added lastly mean was taken. Arbitrarily ten siliqua were chosen from each plot subsequent to harvesting and their length was estimated and normal was determined. Every one of the seeds of ten arbitrarily tested siliqua were tallied and normal was recorded. After fruition of sifting what's more, winnowing, an agent test of seeds was drawn independently from the mass produce of every treatment. With the assistance of electronic seed counter, 1000 seeds were checked and weight was recorded. The aggregate biomass got from each net plot was sifted followed by cleaning and gauging. Seed yield, in this way got was communicated in terms of kg per plot and afterward changed over to kg/ha. The seed yield for each net plot was deducted from individual natural yield and subsequently the stover yield was figured and communicated as far as kg per plot and afterward in kg/ha. The whole over the ground biomass acquired from each net plot was sundried appropriately and after that the weight was recorded and natural yield was communicated as kg/ha. The information gathered of various boundaries were exposed to proper measurable investigation under Split Plot Design by following the strategy of ANOVA examination of fluctuation. Meaning of contrast between implies was tried through 'F' test and the least critical contrast (LSD) was worked out where change proportion was found critical for treatment impact. The treatment impacts were tried at 5% likelihood level for their importance.

Another experiment was conducted by Mukherjee Dhiman *et al*. (2017) which used a split plot design with three replications and five nutritional doses (30:20:20; 45:30:30; 60:40:40; 75:50:50 and main plots (90:60:60 kg N, P2O5, and K2O/ha) and 4 plots (90:60:60 kg N, P2O5, and K2O/ha), planting geometry treatments (25 x 15, 25 x 20, 30 x 15) The subplots are 30 x 20 cm in size. The suggested dosage of 60:40:40 kg of nutrients (RDF) i.e., N, P2O5, and K2O per hectare respectively was found in Indian mustard. Nutrients were applied through urea, single superphosphate and muriate of potash. Indian mustard cultivar 'Giriraj' was planted on ninth October in 2017 and 10th October in 2018. Full measure of phosphorus also, potassium and half measure of nitrogen according to treatments was applied at the hour of planting, while the leftover portion of nitrogen was top dressed at the pre-blooming stage after first water system (23 days in the wake of planting). Any remaining suggested agronomic practices were received during the crop development period in both the years. Plant tallness and leaf region at top development stage for example 60 days subsequent to planting (DAS) were recorded from five arbitrarily chose plants from each plot and found the middle value of. Plant tallness, expanding, number of siliquae/plant were recorded at reap (120 DAS) from five haphazardly chose plants. The seed and stover yield was registered from the yield got from net plot (5 x 4 m 2) also, communicated in kg/ha. Starting soil status (0-15 cm) and plant uptake at collect for nitrogen, phosphorus and potassium were resolved according to standard research facility methodology. (Jackson, 1973). Sulfur take-up in plant was broke down by turbidimetric strategy (Williams and Steinbergers, 1959). Oil percent in the Indian mustard seed was controlled by Soxhlet mechanical assembly utilizing oil ether (60-80ºC) as an extractant (A.O.A.C., 1960). Measurable investigation of the pooled information of development, yield ascribes and yields were performed by applying the method of investigation of change (ANOVA) recommended for split plot configuration to test the meaning of contrast among medicines and ends were drawn at 5% likelihood level. Cost of development (/ha) was determined considering the overall charges of rural activities and market cost of information sources included. Net returns were gotten by changing over the collect into money related terms at the common market rate. Advantage: cost proportion (B:C) was acquired by partitioning the gross pay with cost of development.

Application of 60:40:40 kg N, P2O5 and K2O/ha, respectively (100% RDF) significantly increased the plant height, dry matter accumulation, leaf area index at 60 DAS, number of primary and secondary branches/plant, seeds/siliqua, 1000 seed weight, seed yield and stover yield over lower doses of nutrients (30:20:20 and 45:30:30 kg N, P2O5 and K2O/ha, respectively). Increase in plant height with application of 90:60:60 kg N, P2O5 and K2O/ha, respectively and number of siliquae/plant, seeds/siliqua and stover yield with application of 75:50:50 kg N, P2O5 and K2O/ha, respectively over 60:40:40 kg N, P2O5 and K2O/ha, respectively was also significant. Leaf area index, number of secondary branches/plant, 1000 seed weight and seed yield increased up to 75:50:50 kg N, P2O5 and K2O/ha, respectively but such increases were non-significant over 60:40:40 kg N, P2O5 and K2O/ha, respectively. The marked improvement in growth with higher doses of nutrients could be ascribed to more response of plant to nutrient availability, which helped to exploit available resources for growth and development. The improvement in growth (plant height, number of primary and secondary branches/plant) and yield parameters with increased nutrient doses might be due to the enhanced availability of nutrient to the plant. Similar results were reported by Ram *et al*. (2003) and Kumar *et al*. (2001). The positive response of higher levels of nutrients on yield attributes could be ascribed to overall improvement in crop growth enabling the plant to absorb more nutrients and moisture and accumulate more quantities of photosynthates (Tripathi *et al*., 2010; Rana *et al*., 2005). Application of 75:50:50 and 60:40:40 kg N, P2O5 and K2O/ha, respectively increased the seed yield by 48.0 and 41.5% over 45:30:30 kg N, P2O5 and K2O/ha, respectively. The seed yield is the cumulative sum of all the yield components. Therefore, improvement in yield components significantly enhanced the seed yield. Similarly, substantial increase in seed and stover yield of mustard due to nitrogen application has also been reported by Mandal and Sinha (2004). Since phosphorus is a constituent of nucleic acid, phytin and phospholipids, enzymes responsible for transformation of energy, carbohydrates and fat metabolism, its increased uptake resulted in better growth and increased yield (Chouksey *et al*., 2016). Similar results were reported by Mandal and Sinha (2004). Potassium is involved in carbon assimilation, photosynthesis, starch formation, translocation of protein and sugar, entry of water into plants, root development. Increased growth attributes under adequate potassium supply was responsible for better performance of yield attributes which increased with higher rate of fertilizer consisting of higher levels of potassium (Mukherjee, 2016).

Result and Discussion

Application of nutrients failed to influence the N content in stover, P and K content in both seed and stover and S content in seed (Table 2). Successive doses of nutrients up to 75:50:50 kg N, P2O5 and K2O/ha, respectively significantly increased the N content in seed. Total uptake of NPK and sulphur increased with application of 90:60:60 kg/ha of N, P2O5 and K2O, respectively. However, such increases were significant up to 60:40:40 kg N, P2O5 and K2O/ha, respectively for seed and up to N, P2O5 and K2O, respectively for stover. Oil content decreased with successive increase in dose of nutrients from 45:30:30 kg N, P2O5 and K2O/ha, respectively to 90:60:60 kg N, P2O5 and K2O/ha, respectively and protein content increased with each successive dose of nutrients up to 75:50:50 kg N, P2O5 and K2O/ha, respectively. The reduction in oil content and increase in protein content with increase in nutrient doses might be due to the utilization of carbohydrates in protein synthesis (Kumar *et al*. 2001, Ram *et al*., 2003, Singh and Singh, 2015). Increase in protein content was due to higher nitrogen content which is precursor of protein synthesis in seed. The highest oil and protein yields registered with the 75:50:50 kg N, P2O5 and K2O/ha, separately were at standard with the 60:40:40 kg N, P2O5 and K2O/ha, separately and 90:60:60 kg N, P2O5 and K2O/ha, separately for oil yield and 90:60:60 kg N, P2O5 and K2O/ha, individually for protein yield. Utilization of 75:50:50 kg N, P2O5 and K2O/ha, individually gave greatest net return (43,250/ha) with B:C proportion of 3.01. Planting math of 30 x 15 cm enrolled altogether more plant tallness, number of siliquae/plant and seeds/siliqua than planting math of 25 x 15 cm and 25 x 20 cm while comparative expansion in number of siliquae/plant was huge more than 30 x 20 cm (Table 1). Plant dispersing of 30 x 20 cm enrolled most noteworthy dry matter gathering and was at standard with the 25 x 20 cm plant dividing. More extensive dividing expanded the fanning and brought about more dry matter gathering/plant. Planting calculation of 30 x 20 cm enlisted fundamentally more LAI than 25 x 15 cm and 25 x 20 cm and number of optional branches/plant more than 25 x 15 cm. Plant dividing of 30 x 20 cm enlisted essentially higher 1000 seed weight than 25 x 15 cm dividing.

Table 1: Effect of treatments on growth and yield attribute of Indian mustard (pooled data of two years)

Treatments	Plant height at 120 DAS	Number of primary branches/plant	Number of secondary branches/plant	Number of siliqua/plant	Seeds/ siliqua	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest Index (%)
Doses of nutrients (kg N P_2O_5 and K_2O)								
30:20:20	119.5	5.3	7.2	278	7.3	871	2392	26.69
60:40:40	133.8	7.1	9.3	324	9.8	1674	4881	25.54
90:60:60	141.1	8.2	9.0	353	10.2	1733	6081	22.18
SEm±	2.0	0.4	0.3	7.6	0.3	26.2	78.7	0.35
CD (p=0.05)	4.8	1.1	0.9	21.0	0.8	74.4	220.3	0.98
Planting geometry (cm)								
25 x 15	121.2	6.2	7.8	279	8.0	12.46	3120	28.54
25 x 20	126.1	7.2	9.0	332	9.4	16.44	5113	24.33
30 x 15	141.0	7.0	8.9	405	10.0	15.01	4908	23.42
SEm±	1.8	0.3	0.3	7.0	0.2	20.9	68.0	0.29
CD (p=0.05)	5.5	0.9	0.8	23.1	0.7	61.0	213.6	0.78

***Source*:** Mukherjee *et al*. (2016)

Seed yield got with the 25 x 20 cm separating (1644 kg/ha) was essentially higher than any remaining dispersing medicines. Planting calculation of 25 x 20 cm enrolled 24.2% more yield over plant dividing of 25 x 15 cm. The thick plant populace diminished the yield because of decrease in the photo synthetically dynamic leaf region brought about by common concealing (Mukherjee, 2010). This treatment was trailed by 30 x 15 cm and 30 x 20 cm dispersing. Also plant separating of 25 x 20 cm registered significantly more stover yield (5113 kg/ha) than 25 x 15 cm and 30 x 15 cm dividing. Plant separating with 25 x 15 cm separating enrolled essentially more harvest record than any remaining medicines of planting math. Planting geometry of 30 x 15 cm brought about most noteworthy N take-up in seed, stover and absolute take-up however such increments were huge more than 25 x 15 cm just if there should be an occurrence of seed and complete N take-up (Table 2). The P take-up by seed, stover and aggregate enlisted if there should be an occurrence of 25 x 20 cm dividing were essentially higher than 25 x 15 cm dividing. Essentially K take-up by stover also, all out enlisted in the event of 25 x 20 cm were altogether higher than 25 x 15 cm and 30 x 20 cm separating. Sulfur take-up with planting math of 30 x 15 cm was altogether higher than planting calculation of 25 x 15 cm. Closer dividing (25 x 20 and 25 x 15 cm) came about in essentially higher oil content and more extensive dispersing (30 x 20 also, 30 x 15 cm) in essentially higher protein content over other yield calculations. Comparative outcome was seen by Yadav *et al*. (2010) [21]. Yield calculation of 25 x 20 cm registered most elevated oil yield which was practically identical with that of 30 x 15 cm separating. Nonetheless, higher protein yield was gotten with the 30 x 30 cm dividing firmly followed by 25 x 20 cm and 30 x 20 cm plant separating. The most noteworthy net return (43,260) was gotten with the 25 x 20 cm plant dividing with B:C proportion of 3.32. Be that as it may, most extreme advantage: cost proportion (3.51) was recorded with the plant separating of 30 x 15 cm.

Therefore, association impacts of dividing and nutrient supply portions for different development and yield ascribes and yield were non-huge. In this manner utilization of 75:50:50 kg N, P2O5 and K2O/ha, individually brought about higher seed and oil yields looked at to bring down portions of supplements. Yield geometry of 25 cm x 20 cm was discovered ideal for watered opportune planted Indian mustard for higher net returns and advantage: cost proportion.

References

1. Bharati V, Prasad UK, Singh JP. Irrigation and sulphur on yield and nutrient uptake of Indian mustard. Journal of Farming Systems Research and Development 2003;8(1):97-98.
2. Bhari NR, Siag RK, Mann PS. Response of Indian mustard (*Brassica juncea*) to N and P on Torrips amments of north-western Rajasthan. Indian Journal of Agronomy 2000;45:746-51.
3. Chauhan DR, Ram M, Singh I. Response of Indian mustard to irrigation and fertilization with various sources and levels of sulphur. Indian Journal of Agronomy 2002;47(3):422-426.
4. Dongarkar KP, Pawar WS, Khawale VS, Khutate NG, Gudadhe NN. Effect of nitrogen and sulphur on growth and yield of mustard (*Brassica juncea* L.). Journal of Soils and Crops 2005;15:163-67.
5. Garnayak LM, Singh NP, Singh S, Paikaray RK. Influence of irrigation and nitrogen on growth, yield and nutrient uptake by late sown Brassica oilseeds. Indian Journal of Agronomy 2000;45:371-78.
6. Ghanbahadur MR, Lanjewar BK. Influence of sowing dates, irrigation levels and mulching on nutrient uptake and yield of mustard cv. ACN-9. Journal of Soils and Crops GOI, 2018. Agricultural Statistics at a Glance. Agricultural Statistics Division, Department of Agriculture and Cooperation and Farmers Welfare, Ministry of Agriculture, GOI, New Delhi 2006;16(1):158-164.
7. Kumar A, Kuma RS. Crop growth rate and developmental characteristics of Indian mustard var Vardan to varying levels of nitrogen and sulphur. Indian Journal of Agricultural Research 2008;42:112-15.
8. Kumar D, Singh S, Sharma SN, Shivay YS. Relative efficiency of urea and dicyandiamide-blended urea on mustard (*Brassica juncea*) varieties. Indian Journal of Agronomy 2000;45:179-83.
9. Kumar V, Ghosh BC, Bhat R, Karmakar S. Effect of

irrigation and fertilizer on yield nutrient uptake and water use efficiency on mustard [(*Brassica juncea* L.) Czerni & Cosson] on. Acid Laterite soil. Journal of Oil Seeds Research 2000;17(1):117-121.

10. Malagoli P, Laine P, Rossato L, Ourry A. Dynamics of nitrogen uptake and mobilization in field grown winter oilseed rape (*Brassica napus*) from stem extension to harvest. Annuals of Botany 2005;95:853-61.
11. Parmar BS, Patel MM, Patel JC, Patel DM, Patel GN. Enhance mustard [*Brassica juncea* (L.) Czern and Coss] productivity through sprinkler irrigation under north Gujarat conditions. Research on Crops 2016;17(1):63-67.
12. Piri I, Nik MM, Tavassoli A, Rastegaripour F. Effect of irrigation intervals and sulphur fertilizer on growth analyses and yield of *Brassica juncea*. African Journal of Microbiology Research 2011;5(22):3640-3646.
13. Reager ML, Sharma SK, Yadav RS. Yield attributes, yield and nutrient uptake of Indian mustard (*Brassica juncea*) as influenced by nitrogen levels and its split application in arid western Rajasthan. Indian Journal of Agronomy 2006;51:213-16.
14. Sharma G, Sutaliya R, Prasad S, Sharma ML. Effect of irrigation and intercropping system on growth, yield and quality of mustard and linseed. Journal of Crop Research 2003;25(3):579-581.
15. Sharma OK, Kumar A. Effect of nitrogen fertilizer under different irrigation scheduling on production potential and economics of mustard. Fertilizer News 1992;37:37-41.
16. Singh SP, Pal MS. Effect of integrated nutrient management on productivity, quality, nutrient uptake and economics of mustard (*Brassica juncea*). Indian Journal of Agronomy 2011;54(4):381-387.
17. Singh AK, Singh SN, Singh OP, Khan MA. Quality of Indian mustard (*Brassica juncea* L.) as affected by nitrogen and sulphur fertilizers in a Int. J Curr. Microbiol. App. Sci 2020;9(7):1735-1746 nutrient deficient soil. Indian Journal of Agricultural Biochemistry 2008;21:39-41.
18. Singh A, Meena NI. Effect of nitrogen and sulphur on growth, yield attributes and seed yield of mustard (*Brassica juncea*) in eastern plains of Rajasthan. Indian Journal of Agronomy 2004;49(3):186-188.
19. Singh BN, Srivastava SP. Effect of irrigation and nitrogen fertilization on growth and yield of mustard in mid hills of Meghalaya. Indian Journal of Agronomy 1986;31(2):135-138.
20. Singh SP, Pal MS. Effect of integrated nutrient management on productivity, quality, nutrient uptake and economics of mustard (*Brassica juncea*). Indian Journal of Agronomy 2011;56:381-387.
21. Yadav RP, Tripathi ML, Trivedi SK. Yield and quality of Indian mustard (*Brassica juncea*) as influenced by irrigation and nutrient levels. Indian Journal of Agronomy 2010;55(1):56-59.