Int.J.Curr.Microbiol.App.Sci (2018) Special Issue-7: 5261-5269

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Special Issue-7 pp. 5261-5269**
Journal homepage: http://www.ijcmas.com

Original Research Article

Effect of Integrated Nutrient Management on Yield and Economics of Mustard (*Brassica juncea* L.)

Rama Kant Singh, Pankaj Kumar, S.K. Singh, S.B. Singh and R.N. Singh*

Krishi Vigyan Kendra, Katihar, India
Bihar Agriculture University, Sabour, Bhagalpur, India
**Corresponding author*

Keywords

FYM, Nutrient use efficiency, Fertilizers, mustard, seed yield, net return

A B S T R A C T

A field experiment was conducted at farmer field of Katihar district during two consecutive years of 2013-14 and 2014-15 to investigate the effect of integrated nutrient management on soil properties and performance of mustard (*Brassica juncea* L). The soil is non-calcareous light gray in colour flood plain belongs to the alluvial gangetic plain (Agro climatic zone II). The study was done in RBD with three treatments and ten replications with variety Pusha Bold to evaluate the observation regarding growth attributes and yield components mustard. The land was prepared in early November and nutrients are applied as per treatments (T_1 = farmer practices, T_2 = RDF through SSP, T_3 = soil test based fertilizers application and T_4 = soil test based fertilizers application (75% through chemical fertilizers + 25 % through organic fertilizers), respectively. Results revealed that different fertility levels had significant effect on all growth and yield parameters i.e. number of branches, number of pods, length of plant, test weight, no of seed /pod, weight of seed, weight of straw, Biological yield, harvesting index and BC Ratio. The use of soil test based fertilizers application through 75% chemical fertilizers and 25 % with organic manure resulted in significantly higher seed yield of mustard (20.93 q ha^{-1}) followed by soil test based fertilizers application (16.90 q ha^{-1}), nutrient application as par RDF (15.96 q ha^{-1}) and farmers practices (13.15 q ha^{-1}), respectively. Balance fertilization at right time with proper method and sources nutrient uses efficiency and productivity of mustard. Twenty five per cent inorganic fertilizers can be saved by use of FYM without deterioration in mustard yield.

Introduction

The oilseed form essential part of human diet. Besides it produces basic raw materials for agrobased industries and has large acreage covering 20.7 million ha under various oilseeds in different agro-climatic zones of this country. The average Indian consumer uses relatively low quantities of edible oil, no doubt influenced by his modest level of income. The annual per capita "disappearance" of oils and fats in 1999 was as high as 82.3 kg in Malaysia, 47 kg in USA, 45.8 in EU-15, 17.3 kg average for the world as a whole and 11.9 kg in China as against 9.9 kg in India. This has been primarily due to phenomenal increase in human population and lower rate of productivity of these crops. Rapeseed and mustard are the major *Rabi* oilseed crops of India and stand next to groundnut in the oilseed economy. Rapeseed and mustard are one of the most important edible oils of northern and eastern parts of India. Various

nutrients and micronutrients are required for oilseed production, but the nutrient which plays a multiple role in providing nutrition to oilseed crops, particularly those belonging to cruciferae family. Each unit of fertilizer sulphur generates 3-5 units of edible oil, a commodity needed by every family. Sulphur can be rightly called as fourth major element of the plant because it is a constituent of three amino acids and helps in the formation of chlorophyll and synthesis of oils. Sulphur application also has marked effect on soil properties and is used as soil amendment to improve the availability of other nutrients in soil as gypsum and pyrite. Sulphur is the cheapest of the four major plant nutrients today. Between the two common sources of sulphur, a relatively large deposit of gypsum are available in India and is a cheap source of sulphur, hence could also be better source of sulphur for oilseed crops. Khan and Hussain (1999) showed the highest seed and oil yield in mustard (*Brassica juncea*) cv. Pusa Bold was obtained by applying 20 kg sulphur per hectare.

Organic mannures are known to play a number of vital roles in soil fertility, crop productivity and production in agriculture as they are eco-friendly and can be replace 25 percent chemical fertilizers that are able to get maximum crop yields. They supplement chemical fertilizers for meeting the integrated nutrient demand of the crops. The inoculants of organic manure in soil plants, promote seed germination and initial vigor of plants by producing growth promoting substances. Application of organic manure results in increased mineral and water holding capacity and uptake, root development, vegetative growth and nitrogen fixation. Therefore, present study deals with the Effect of Integrated Nutrient Management on soil properties and Performance of Mustard (*Brassica juncea* L.).

Materials and Methods

The experiment was conducted at Farmers field of Katihar district by Krishi Vigyan Kendra, Katihar, (Bihar Agricultural University Sabour, Bhagalpur) during two consecutive years of 2013-14 and 2014-15 to study the Effect of Integrated Nutrient Management on Soil Properties and Performance of Mustard (*Brassica juncea* L). It lies between Latitude 25'N to 26'N, Longitude 87' to 88'E with an altitude of 32 m above MSL. The climate is sub-tropical and humid having mean maximum and minimum temperature between 44^0C and 4^0C, respectively and the average annual rainfall of the district is about 1200 mm.

Experimental site and soil analysis

The experimental soils are non-calcareous light gray flood plain belongs to the Alluvial Tract (Agro ecological zone-II) lies between three major rivers Mahananda, Kosi and Ganga. The soil samples were collected from different farmer field before start the experiment and after harvesting of the crop and at each sampling site, soil samples were collected from top soil and finding are presented in table 1. The soil texture varies from sandy loam to sandy clay with noncalcarious light gray flood plain belong to alluvial tract. In October 2013 and April 2014 and October 2014 and April 2015, surface soil samples were collected with the help of Augar with experimental field. At each sampling point four cores (5.0 cm diameter) were randomly taken within one meter at each other to a depth of 15 cm. About 500 g composite soil samples were obtained after combining at each point. A total of 75 % composite soil samples were air dried and pass through 2mm sieve. Organic carbon content was determined by the Walkley and Black method (1934). Available nitrogen was determined by the

alkaline $KMNO_4$ method (Subbaiah and Asija, 1956), and available phosphorous (Olsen's method, 1954) and available potash were determined Flamphotometrically method (Tandon, 1993), available sulphur was determined turbidetry method (Hunter, 1984). The pH and ECe were measured in soil suspension (1:2.5) using electrode (Chopra and Kanwar, 1991).

Experimental treatments and design

The experiment was laid out in RBD with four treatments and ten replications. There were altogether 40 unit plots in the experiment. The unit plot size was 4.0m X 2.5m. The land was prepared in early November and nutrients are applied as per treatments (T_1 = farmer practices (urea 25 kg, 50 kg DAP, 25 kg MOP), T_2 = RDF through SSP, T_3 = soil test based fertilizers application and T_4 = soil test based fertilizers application (75 % through chemical fertilizers + 25 % through organic fertilizers) respectively. All the fertilizers were applied as per treatments dose in each individual plot during the final land preparation and rest nitrogenous fertilizer were applied as per different stages recommended in different treatments. Mustard Seed var Pusa Bold in were sown on 18th November 2013 and 24thNovember 2014 at the rate of 5 kg ha^{-1} after application of treatments wise manure and fertilizers with 30 cm row spacing of to evaluate the observation regarding growth attributes and yield components. Three irrigations were applied during crop season at branching stage 30 DAS, flowering stage 50 DAS and pod filling stage 85 DAS. The crop was harvested on 30 March 2014 and 8 April 2015. The experimental data recorded for growth parameters, yield attributes and yield was statistically analyzed by Fisher's 'Analysis of Variance' technique (Fisher, 1950).

Results and Discussion

Effect treatments on soil properties

Owing to its high yield potential and nutrient demand, the continuation of vegetable production resulted in the extensive removal of essential plants nutrients from the soil. That led to the depletion of soil nutrient reserves which caused a decline in the crop productivity as well as the total factor productivity of the soil. Indiscriminate use of heavy doses of high analysis NPK fertilizers free from micronutrients and diminished use of organic manures and little recycling of crop residues and little recycling of crop residues in the intensive vegetable cropping system has led to an exaggerated the deficiencies of micro, secondary and micro nutrients. These micronutrient deficiencies have not only become a serious implement in sustaining higher vegetables and grains yield but have also caused a serious micronutrients malnutrition problem in human being and livestock. Among the secondary nutrients, sulphur is being the problematic elements under the Onion cultivation.

The physico-chemical properties of experimental soils (before sowing and after harvesting) are presented in table 1. An inconsistent change in soil pH and ECe were noted; organic carbon increased from 0.27 to 0.29 per cent in before transplanting and 0.28 to 0.32 per cent due to application of sulphur through single super phosphate with FYM. In experimental field no appreciable rise of organic carbon was noted. The status of available NPK in before transplanting of crop was 216.9 to 218.8, 17.90 to 19.0 and 252.70 to 256.10 kgha^{-1} and after harvesting 204.5 to 208.2, 16.6 to 19.7 and 247.90 to 261.50 kg ha^{-1}, respectively in different treatments. It is clear from the data that NPK status decrease due to uptake and other source of losses. Data related to response of

sulphur deficiencies and applications in soil have been presented in table 1. The level of sulphur is 5.57 to 5.96 mg ha^{-1} in before start the experiment and after experiment it is varies from 5.35 to 6.65 mg ha^{-1}.

Effect treatments on plant growth attributes and yield of mustard

Plant height

Results showed that, plant height was significantly affected by different combined (Table 2). The highest plant height 155 cm was obtained by treatment T_4 (soil test based fertilizers application (75 % through chemical fertilizers + 25 % through organic fertilizers), followed by T_1 (farmer practices), T_2 (RDF through SSP) and T_3 (soil test based fertilizers application). Comparing with farmer practice, plant height increased 4.84, 10.61 and 23.87 % by utilization of T_2, T_3 and T_4, respectively. The reason for better growth and development in the above treatments might be due to increased availability of nitrogen and phosphorus to the plant initially through fertilizers and then through manures in the cropping season. FYM plays an important role in better development of roots and increased microbial activity because of balanced nutritional environment probably both in soil rhizosphere and plant system results in better growth and development of mustard crop. These results are in agreement with those of Singh (2007) who observed higher values of growth parameters due to application of fertilizers and manures in combination.

Number of secondary branches/plant

The two years pooled data related to branch per plant have been presented in table 2. It is clear from the data recorded that the effect of different treatments was significant on number of branches/plant and found more number of secondary branches per plant in T_4 (12.32) than other treatments 12.11, 12.02 and 11.72 in T_3, T_2 and T_1, respectively. Application of 75 % inorganic and 25 % organic fertilizers after soil test value might have increased the availability of nitrogen to the plant at early growth stages and nitrogen being an essential constituent of nucleic acid, protoplasm and protein, play a fundamental role in metabolism, growth, development, reproduction and transmission of heritable characters, so the number of secondary branches also increased by this condition. These results were in conformity with those of Prasad and Ehsanullah (1988).

Number of siliqua $plant^{-1}$

The pooled data in table 2 showed all the treatments were significantly superior to farmers' practice in respect to number of siliqua $plant^{-1}$. Addition of 25 % organic fertilizers with 75 % chemical fertilizers levels gave significantly higher value (187) than other treatment combinations169, 170, 178 in T_1, T_2 and T_3, respectively. During the both year the results followed the same trend was also significantly had higher number of siliqua over control.

Number of seeds $siliqua^{-1}$

As pooled data shown in table 2 the number of seeds $siliqua^{-1}$ varied from 6 to 8 and lowest and highest value given by (T_1) farmer practice and (T_4) soil test based fertilizers application (75 % through chemical fertilizers + 25 % through organic fertilizers gave. Addition of 25% organic fertilizers in combination of 75 % chemical fertilizers gave higher values than other treatment combnation but the differences were non significant. A number of investigators have observed increases in

these attributes in mustard crop *viz*. Tripathi *et al*. (2011),Chaurasia *et al.* (2009), Ramesh *et al.* (2009) and Kashved *et al.* (2010). The results of present study are in agreement with the findings of above workers.

Table.1 Effect of different treatments on physico-chemical properties of soil (2 years pooled)

Treatments	pH (1 : 2.5)		ECe (d Sm^{-1})		OC (%)		N		P		K		S	
							Available Nutrients (kgha^{-1})						(mgha^{-1})	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
T_1	6.8	6.8	0.028	0.029	0.27	0.28	217.0	204.5	18.10	16.6	252.70	247.90	5.57	5.35
T_2	6.8	6.9	0.029	0.031	0.29	0.31	216.9	208.8	19.00	19.0	253.80	256.60	5.83	6.38
T_3	6.8	6.9	0.029	0.031	0.27	0.30	217.9	206.5	18.60	19.3	256.10	259.10	5.96	6.65
T_4	6.8	7.0	0.031	0.033	0.28	0.32	218.8	208.2	17.90	19.7	254.80	261.50	5.86	6.57
Mean	6.8	6.9	0.029	0.031	0.28	0.30	217.7	207.0	18.40	18.7	254.35	256.28	5.81	6.24
CD (p=0.05)	NS	NS	NS	NS	0.02	0.03	1.27	1.13	0.05	0.02	1.15	2.18	0.04	0.07

Table.2 Effect of different treatment on growth attributes of mustard (2 years pooled)

Treatments	Plant height (cm)	Branches $plant^{-1}$	Siliquae $Plant^{-1}$	Siliquae length (cm)	Test weight (gm)	Seeds $siliquae^{-1}$
T_1	118	11.72	169	3.57	4.98	6
T_2	124	12.02	170	3.77	5.02	7
T_3	132	12.11	178	4.07	5.04	7
T_4	155	12.32	187	4.37	5.11	8
Mean	132.25	12.04	176	3.95	5.04	7
CD(p=0.05)	3.53	0.06	2.06	0.04	0.02	0.02

Table.3 Effect of different treatment on yield attributes and economics (2 years pooled)

Treatments	Seed Yield (qt ha^{-1})	Straw Yield (qt ha^{-1})	Biological yield (qt ha^{-1})	Harvesting Index	Cost of Cultivation (Rs)	Gross return (Rs)	Net Return (Rs)	BC Ratio
T_1	13.15	15.22	28.37	46.36	11920	34194.46	22274.46	2.87
T_2	15.96	17.56	33.52	47.61	12150	41487.38	29337.38	3.41
T_3	16.90	18.25	35.15	48.08	12305	43939.34	31634.34	3.57
T_4	20.93	21.32	42.25	49.54	12408	54415.68	42007.68	4.39
Mean	16.74	18.09	34.82	47.90	12195.75	43509.22	31313.47	3.56
CD(p=0.05)	1.42	1.86	2.05	ND	135.22	205.02	158.74	ND

Grain yield

The average seed yield had significant effect of fertilizer management levels at crop harvest. The yield increased progressively and significantly with each successive treatment application. In T_4 level, the pooled seed yield was 20.93 as against 13.15, 15.96 and 16.90 q ha^{-1} recorded in T_1, T_2 and T_3 levels, respectively. Thus, the difference in yield resulting from soil test based fertilizers application (75 % through chemical fertilizers + 25 % through organic fertilizers application was significant. The results are

summarized in table 2. Similar result has been reported by Kumar and Kumar (1994). The interaction between 75 % chemical fertilizers and 25 % organic fertilizers on grain yield was significant.

Straw yield

The effect of different treatments was significant in forage yield. Application of 75% through chemical fertilizers + 25 % through organic fertilizers after soil test value recorded significantly higher straw yield than only chemical application on the basis of recommended dose of fertilizers and other treatments, which in turn gave significantly higher straw yield than other application of fertilizes of treatments. The increase in straw yield also may be attributed to higher plant height than more number of total branches. A similar result was also reported by Sharma (1994), Prassad (1995), Malavia *et al*. (1988) and Sharma (1992). This may be due to the effect of organic and inorganic fertilizers combination to increasing growth attributes and production of more dry matter. Sharma (1994) and Jat *et al.* (2003) also reported an increase in forage yield of mustard with increasing sulphur levels.

Biological yield

The results related to biological yield showed significant differences between different treatment combinations (Table 3). The results indicated that the highest biological yield was obtained when applied 75 % through chemical fertilizers and 25 % through organic fertilizers fertilizer (T_4). Biological yield increased 32.85, 19.29, and 15.36 % by T_4, T_3 and T_2 in comparing with control (T_1), respectively. Such effects of different treatments might be due to the play of critical role in crop growth, involving in photosynthesis processes, respiration and other biochemical and physiological activates and thus their importance in achieving higher yields (Tripathi *et al*., 2010).

Harvest index

These results show that the application organic and inorganic fertilizers after soil test value significantly increased harvest index (Table 2). On an average, application of different treatment increased harvest index by 6.86, 3.71, and 2.70 per cent over the farmer practice. Whereas, T_4 treatment produced maximum grain and biological yield, so increase harvest index in it treatment is absolutely. The increase in the studied characters due to micronutrients may be attributed to its influences in enhancing the photosynthesis process and translocation of photosynthetic products to the seed as a result of increase enzymatic activity and other biological activities. The present trend of increase in harvesting index is in close conformity with the findings of Abraham *et al.* (2008) and Maheshbabu *et al.* (2008).

Cost of cultivation:

The data related to cost of cultivation have been presented in table 3. It is clear from the above data that the cost of cultivation of mustard varied from Rs.11920 to Rs.12408 per ha. The maximum cost of cultivation was observed with treatment T_4 and minimum with T_1. It is possible due to the application of organic and inorganic fertilizers in combination due to that labour cast gone up but the increase the physico-chemical properties of soil and availability of balance nutrients the total production were increase over to control.

Gross income

It is clear from the data presented in table 3 that the gross income of mustard crop varied from Rs. 34194 to Rs.43509 per ha. The

maximum gross return was found Rs.54415 with treatment T_4 (soil test based fertilizers application (75% through chemical fertilizers + 25 % through organic fertilizers) and minimum Rs.34194 with T_1 (farmer practice).

It is clear with our findings the maximum return with T_4 might be due to highest yield of biological yield per ha. It is possible due to the application of organic and inorganic fertilizer due to that the availability of nutrients is in increased and total production was also increased so that the gross return was increased.

Net income

It was observed from data (Table 3) that net income with the application of combination of organic (25 %) and inorganic (75 %) varied from Rs. 22274 to Rs. 42007 per ha. Net income (Rs. 42007) was found maximum with the treatment T_4 and minimum (Rs. 22274) with the treatment T_1. Minimum income may be due to more expenditure and low biological yield.

BC ratio

The Benefit Cost Ratio (BC ratio) is defined as the amount received against the profit gained on investment/ costs of one rupee. The BC ratio was computed by borrowing the methods that employed by Ramesh *et al.* (2009)

BC R = Nr/TC
Nr = Stands for net returns
TC = Denotes total cost

It was found from data (Table 3) that B C ratio varied from 2.87 to 4.39. It was found maximum with the treatment T_4 and minimum B C ratio with treatment T_1.

Acknowledgements

The authors greatly appreciate the research facilities and financial support provided by Indian Council of Agricultural Research, New Delhi and BAU, Sabour, Bhagalpur and all those who cooperate and support to complete these work along with farmers.

References

Abraham, T., Thenua, O. V. S., Singh, S. P. and Jacob, P. 2008. Performance of groundnut as influenced by organic and inorganic sources of nutrients and their method of application. *Legume Res.* 31: 224-26.

Chauhan, D.R., Shasi-Paroda, Mangat Ram, Paroda, S. and Ram, M. 1996. Response of Indian mustard (*Brassica juncea* L.) to biofertilizers, sulphur and nitrogen fertilization. *Indian J. Agron.* 41(4): 620-623.

Chaurasia, Anand, Singh A.B. and Namdeo, K.N. 2009. Integrated nutrient management in relation to yield and yield attributes and oil yield of Ethiopian mustard (*Brassica carinata*). *Crop Research*. (Hisar). 38 (1/3): 24-28.

Chopra , C.L. and Kanwar, J.S. 1991. Analytical Agricultural Chemistry, Kalyani Publication, New Delhi.

Fisher, R. A. 1950. *Statistical Methods for Research Workers.* Oliver and Boyd, Edinburg, London. pp. 57-63.

Gomez, K.A., Gomez A.A. 1984. Statistical procedures for agricultural research. International Rice Research Institute, John Wiley and Sons.

Hunter, A.H. 1984. Soil Analytical Services in Bangladesh. BARI/Aids Consultancy Report. Contract Aid/388-005, Dhaka. Bangladesh. pp. 1-7.

Jackson, M.L. 1973. Soil chemical analysis,

Prentice Hall of India Pvt. Ltd., New Delhi.

Jat, B.L., Jangir, R.P. and Khangarot, S.S. 2003. Responses of mustard varieties to different levels of sulphur in loamy sand soil. J. Farming Syst. Res. Dev., 8(1):108-109.

Kashved, S.M., Raskar, B.S. and Tamboli, B.D. 2010. Effect of integrated nitrogen management and irrigation regimes on productivity of mustard (*Brassica juncea* L). *Journal of Maharashtra Agricultural Univ*ersities.35 (3): 349-353.

Khan, N. and Hussain, K. 1999. Performance of mustard varieties in relation to doses of sulphur. *Adv.Plant Sci.* 12(1): 115-118.

Kumar, V. and Kumar, V. 1994. Effect of *Azotobacter chroococum* on Indian mustard grown in different soil environments. *Crop Res., Hisar*. 7(3): 446-450.

Maheshbabu, H. M., Ravi Hunje, Patil, N. K. B. and Babalad, H. B. 2008. Effect of organic manures on plant growth, seed yield and quality of soybean. *Karnataka J. agric. Sci.* 21 : 219-21.

Malviya, D.D, Petal, J.C. and Vyas, M.M. 1988. Studies on irrigation, nitrogen and phosphorus levels on growth and yield of mustard. Indian J. Agron., 33: 245-248.

Olsen, S.R., Cole, C.V., Watanable, F.S. and Deam, L.A. 1954. Estimation of available phosphorous in soils by extraction with sodium bicarbonate. U.S.Dept. Agri. Cire. 939.

Prassad, J. 1995. Studies on sulphur use efficiency of mustard (*B. juncea*) as influenced by rate of gypsum application and levels of irrigation. M.Sc. (Ag) Thesis, RAU, Bikaner (Raj.).

Prassad, U.K. and Eshannullah, M. 1988. Effect of irrigation and nitrogen on yield and yield attributes of mustard. Indian J. Agron., 33(1): 47- 51.

Ramesh, P., Panwar, N.R., Singh, A.B. and Ramana, S. 2009. Effect of organic nutrient management practices on the production potential, nutrient uptake, soil quality, input-use efficiency and economics of mustard (*Brassica juncea*). *Indian Journal of Agricultural Sciences.*79 (1): 40-44.

Sharma, A.K., Sharma, A.M. and Sharma, Y.M. 1994. Effect of irrigation, nitrogen and sulphur application on seed yield, quality and sulphur uptake by Indian mustard. Agric. Sci. Digest, 14: 63-67.

Sharma, G., Sutaliya, R., Prassad, S. and Sharma, M.L. 2003. Effect of irrigation and intercropping system on growth yield and quality of mustard and linseed. J. Crop Res., 25(3): 579-581.

Sharma, J.P. 1994. Response of Indian mustard to different irrigation schedules and nitrogen and sulphur levels. Indian J. Agron., 39: 421-425.

Sharma, O.K. and Kumar, A. 1992. Effect of nitrogen fertilizer under different irrigation scheduling on production potential and economics of mustard. Fertilizer News, 37: 37-41.

Singh, B., Kumar, A., Yadav, Y.P. and Dhankhar, R.S. 2000. Response of *Brassica* to sulphur application. Indian J. Agron., 45(4): 752-755.

Subbaiah, B.V. and Asija, G.L. 1956. A rapid method for the estimation of available nitrogenin soil. Curr. Sci., 25:259-260.

Tandon, H.L.S. 1993. Methods of analysis of soil, plants, waters and fertilizers. Fertilizers Development and consultation organization, New Delhi.

Tomar, T.S., Singh, S., Kumar, S. and Tomar, S. 1997. Response of Indian mustard to nitrogen, phosphorus and

sulphur fertilization. Indian J. Agron., 42(1): 148-151.

Tripathi, M.K., Chaturvedi, S., Shukla, D.K. and Mahapatra B.S. 2010. Yield performance and quality in Indian mustard (*Brassica juncea*) as affected by integrated nutrient management. *Indian Journal of Agronomy*, 55 (2): 138-142.

Walkley, A. and Black, I.A. 1934. An examination of the different methods for determining soil organic matter and a proposed modification of the eronic acid titration methods. Oil Sci. 37:29-38.

Yusuf, M. 1973. Effect of frequencies and timings of irrigation on growth, yield and quality of safflower, mustard and linseed. Ph.D. thesis, Division of Agronomy, Indian Agricultural Research institute, New Delhi.