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Performance of new genotype of Indian mustard (*Brassica juncea* (L.) Czernj. Cosson) as influenced by sowing time and nutrient management

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Abstract

The field experiment was conducted to study the effect of sowing time and nutrient management on performance of new genotype of Indian mustard (*Brassica juncea* (L.) Czernj. Cosson) at experimental farm of Department of Agronomy, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur during *Rabi* 2019-2020. Soil of the experimental site was silty clay loam in texture, acidic in reaction, medium in organic carbon, low in available nitrogen, medium in available phosphorus and potassium. The experiment was laid out in factorial randomized block design with two factors replicated thrice. The treatments consisted of six nutrient management practices *viz*., Inorganic (RDF), Organic farming, Natural farming, Natural farming + 5 t FYM/ha, Natural farming + 7.5 t FYM/ha and Natural farming + 10 t FYM/ha and two dates of sowing (11th October and 26th October). Results revealed that early sown mustard crop produced significantly taller plants and other growth and development parameters *viz*., dry matter accumulation, emergence count, days to 50% flowering and days to physiological maturity. Seed yield, stover yield and biological yield were also high in case of early sown crop than late sown crop. Among nutrient management practices, application of recommended dose of fertilizers remained superior in terms of plant height, dry matter accumulation, emergence count, days to 50% flowering, days taken to physiological maturity, seed yield, stover yield and biological yield.

Key words: RDF, FYM, Natural Farming, Nutrient management, Growth and development, Dates of sowing.

Rapeseed and mustard (*Brassica* spp.) is among the oilseeds of the world with second largest acreage in India after China. Rapeseed and mustard contribute 24.5 per cent in local oilseed production of the country. Rapeseed and Mustard belongs to the group Cruciferae. Major constraints responsible for low yield of rapeseed & mustard in India are lack of high yielding biotic stress resistant varieties, cultivation under rainfed situation and imbalanced use of nutrients. The response of genotypes to different environment and agronomic practices varies and ultimately decides the selection of genotype for a particular environment with optimum time of sowing for stabilized higher yield. Production potential of rapeseed and mustard can be fully exploited with the adoption of suitable agronomic practices and new high yielding genotypes. Among various agronomic techniques, proper sowing time is an important non-monetary input which interacts with day length. The optimum time of sowing provides congenial conditions for better utilization of resources by the crop. It is being observed that there is sudden rise in temperature during February-March, the time which coincides with the reproductive phase of the crop, thereby having an adverse effect on the yield characters and ultimately seed yield and quality of mustard.

To overcome the huge gap between the production and consumption and for enhancing mustard productivity, it is necessary to identify the production constraints which are directly responsible for limiting its productivity. Among various constraints, low and imbalanced fertilization is most important in the state. Therefore, balanced nutrient management is the most critical input for obtaining optimum yield in rapeseed and mustard. Integrated nutrient management, organic farming and natural farming could be the viable options to augment the nutrient demand of mustard crop. Effective and prudent use of organic manures along with inorganic fertilizers can substantially improve crop productivity and also sustain soil health. Application of well decomposed FYM with or without other organic manures not only supplies all the essential macro and micro plant nutrients but also acts as soil binding material and improves the overall soil health by improving soil physical, chemical and biological properties (Dhaliwal *et al*. 2019). Among different nutrient management practices, natural farming (NF) is gaining importance throughout the country. Natural Farming is a new concept introduced with an aim of sustainable development. Natural Farming (NF) is low-input, climate-resilient type of farming that encourages farmers to use low cost locally available inputs, while eliminating the use of chemical fertilizers and synthetic pesticides. Natural farming replaces use of farm yard manure and compost used in organic farming with cover and green manure crops. With the use of cover and green manure crops, humus formation takes places within field as compared to organic farming in which humus formation takes place at the site of FYM and compost preparation (Palekar 2006). Natural farming is based on four aspects *viz*., *Beejamrit, Jeevamrit/Ghanjeevamrit, Acchadana* (*Mulching*) and *Whapasa* (moisture). These four are important pillars of Subhash Palekar Natural farming. These practices have a positive effect on the quality of the soil, improving its fertility and water retention capacity, as well as reducing input costs and farmers' exposure to credit risks (Kumar 2012; Prasada 2016).

The information about the optimum time of sowing of newly developed genotype "Trombay Him Palam Mustard-1" of Indian mustard and its response under different system of nutrient management is not available. Keeping this in view, it was planned to identify the suitable sowing time and study the performance of new genotypes of Indian mustard under different nutrient management strategies.

Materials and Methods

The treatments comprised of two dates of sowing (11th October and 26th October) and six nutrient management practices *viz*., application of recommended dose of fertilizer through chemical fertilizers, organic farming package, natural farming and natural farming practices along with application of 5.0, 7.5 & 10 t FYM/ha. The field experiment was laid out in Factorial Randomized Block Design with three replications during *Rabi* 2019-2020 at the experimental farm of Department of Agronomy, CSKHPKV, Palampur. The soil of experimental field was silty clay loam in texture, acidic in reaction (pH 5.9) and low in available nitrogen (273.3), medium in available phosphorus (24.7) and potassium (205.4). The new cultivar of mustard genotype as per treatments was sown in rows at a distance of 30 cm apart by using 6 kg/ha of seed. In inorganic nutrient management, recommended dose of fertilizers i.e. 60:40:40 kg/ha of N, P_2O_5 and K_2O was applied. In organic nutrient management practice, application of FYM @15 t/ha + seed inoculation with Azotobacter and PSB prior to sowing and 2 sprays of 'Vermiwash' at 30 and 45 DAS were done. In natural farming nutrient management practice, seed treatment with *Beejamrit* + *Ghanjeevamrit* @ 2.5 q/ha (basal) followed by foliar sprays of *Jeevamrit* at 21 days interval + 1 foliar spray of fermented butter milk and mulching were done. In natural farming + addition of 5 t FYM/ha nutrient management practice, seed treatment with *Beejamrit* + *Ghanjeevamrit* @ 2.5 q/ha (Basal) followed by foliar sprays of *Jeevamrit* at 21 days interval + 1 foliar spray of fermented butter milk and mulching were done. In natural farming + addition of 7.5 t FYM/ha nutrient management practice, seed treatment with *Beejamrit* + *Ghanjeevamrit* @ 2.5 q/ha

(Basal) followed by foliar sprays of *Jeevamrit* at 21 days interval + 1 foliar spray of fermented butter milk and mulching were done. While, in natural farming + addition of 10 t FYM/ha nutrient management practice, seed treatment with *Beejamrit* + *Ghanjeevamrit* @ 2.5 q/ha (Basal) + foliar sprays of *Jeevamrit* at 21 days interval + 1 foliar spray of fermented butter milk and mulching were done.

The emergence count was recorded from the sampling area from date of first emergence of seedling till it was constant. The plant height of mustard was recorded by selecting five plants randomly from each plot which were tagged. Height of these tagged plants was recorded from the ground level up to the tip of top branch in the main stalk. The observations were taken at 30, 60, 90, 120, 150 DAS and at harvest. The average of five plants was worked out to get the mean plant height in cm. For recording dry matter accumulation, plant samples from one meter row length on either side in the sampling row next to border row were cut close to the ground surface at 30, 60, 90, 120, 150 DAS and at harvest of the crop. These samples were dried in oven at 70°C till constant weight and thereafter recorded dry matter was converted into g/m^2. For recording 50 % flowering, plots were visited daily after the appearance of first flower. The date on which 50 % plants in the net plot had at least one open flower was recorded and number of days taken to 50 % flowering was calculated from the day of sowing. The physiological maturity of plants was recorded when stems of selected plants turned yellow and siliquae were ripe, the crop was considered to attain maturity and the days from sowing to maturity were counted and recorded as number of days taken to maturity. For recording seed yield, after removing one border row and the remaining plants from the sampling rows from two sides and 0.5 m area from other two sides of the plot, net plot measuring 5.28 m^2 was harvested. After threshing and cleaning the produce from each net plot, the seeds were dried and seed yield was expressed as kg/ha. The stover yield was worked out by subtracting the seed yield from the total biological yield and then expressed as kg/ha.

Results and Discussion

Plant height (cm)

The data on plant height of mustard recorded at 30, 60, 90, 120, 150 DAS and at harvest have been presented in table 1 indicated a progressive increase in the plant height of mustard from 30 DAS till harvest, though the increase was minimal after 120 DAS. The plant height was significantly influenced by different dates of sowing at all the stages of observation. Mustard sowing on 11th October produced significantly taller plants as compared to the second date of sowing i.e. 26th October at all the stages of observation. General reduction in plant height under delayed sowing might be due to low temperature prevailing at the time of germination and initial growing period. Also, appropriate growth conditions available to the early sown crop (11th October) can be considered as the main factor for increased plant height. Similar observations were also reported by earlier workers such as Kurmi (2002), Turhan *et al*. (2011) and Tarighaleslami *et al*. (2012).

The data presented in table 1 revealed that significantly taller plants of mustard at all the stages of observations were recorded in the treatment in which recommended dose of fertilizers (60:40:40) was applied though this treatment was at par with the treatment where natural farming practices were adopted along with application of 10 t FYM/ha, except at 60 DAS where the difference between these two treatments were significant. Further the treatment in which natural farming practices were adopted alone with application of 10 t FYM/ha were also at par with organic farming at all the stages of observation. Significantly lowest plant height was recorded in natural farming treatment though it was also at par with the treatment in which natural farming package was applied along with 5 t FYM/ha. The greater plant height recorded with the application of recommended dose of fertilizers can be attributed to the adequate supply of nutrients to the crop while natural farming practices were not able to meet the nutrients requirement of mustard crop and hence recorded lower plant height at all stages of observation. Application of

natural farming practice alone with 10 t FYM/ha and organic farming package produced plants with statistically similar height because application of higher dose of FYM (15 t FYM/ha in organic farming) may be meeting a large part of the nutrient requirement of mustard crop. These results are in close conformity with the findings of Mandal and Sinha (2002) and Shukla *et al*. (2002).

Dry matter accumulation (g/m^2)

The data on dry matter accumulation by mustard crop under different sowing dates revealed that sowing dates showed significant effect on dry matter accumulation at all stages of observation except at 30 DAS (Table 2). Early sowing of mustard crop on 11th October recorded significantly higher dry matter accumulation by crop at 60, 90, 120, 150 DAS and at harvest as compared to the second date of sowing (26th October). The greater reduction in total dry matter accumulation in plants under delayed sowing may be attributed to sudden drop in temperature during vegetative phase and sharp rise in temperature during reproductive and maturity phase. These results are in conformity with the findings of Khushu and Singh (2005) and Lack *et al*. (2012).

A cursory look at the data presented in table 2 showed significant effect of nutrient management practices on dry matter accumulation at different stages of observation. Significantly highest dry matter accumulation at all the stages of observation was recorded with the application of recommended dose of fertilizers though this treatment was at par with the application of natural farming practices + FYM @ 10 t per hectare and with organic farming practice at 30 DAS. Application of recommended dose of fertilizers was able to meet the nutrient requirement of the crop at all the stages of observation while the treatment in which natural farming practiced, was supplemented the application of 10 t FYM/ha was able to meet the requirement of crop till about 120 DAS, while at later stages of 150 DAS to harvest this treatment was not able to meet the nutrient requirement (owing to higher nutrient demand at seed setting stage) resulting in significantly lower dry matter accumulation as compared to treatments in which low doses of FYM was applied. Significantly lower dry matter accumulation at all stages of observation was recorded in the natural farming treatment indicating the inability of practices adopted in this treatment to meet the nutrient requirement of the mustard crop. The increase in dry matter might be due to luxurious vegetative growth in terms of plants height, leaf area, stem girth and number of branches. The effects of high rate of photosynthesis from vegetative parts to the reproductive parts subsequently resulted in higher dry matter accumulation. It was also observed that the increased availability of different nutrients resulted in higher plant height, dry matter weight, number of leaves and leaf area index (LAI). Prasad (2000) and Singh and Kumar (1999) have also reported similar observation on the growth of mustard attributing mainly due to increasing N levels. The normal effect of nitrogen on growth increased the height and vigor of the crop, increased branching of the inflorescence and total dry matter production, while P and K application directly or indirectly resulted in increase in nitrogen use efficiency (Holmes 1980).

Emergence count per meter row length, days to 50% flowering and days to physiological maturity

The data on the emergence count of plants (recorded as per meter row length), days to 50% flowering and days to physiological maturity significantly affected by different dates of sowing and nutrient management practices is given in table 3. Mustard crop sown on first date (11th October) produced significantly highest number of plants per meter row length, lesser days taken to 50% flowering and more days taken to physiological maturity as compared to second date of sowing (26th October). Higher plant population at emergence recorded in earlier sowing (11th October) may be ascribed to occurrence of optimum temperature during germination. Similar findings were also reported earlier by Singh and Singh (2002). Early sown crop (11th October) took significantly longer duration to physiological maturity. Similar findings were also reported by Singh *et al*. (2017). Better growth of earlier sown crop may be attributed to favorable soil moisture condition and relatively warmer temperature during

vegetative phase and conducive temperature for early flowering leading to better plant relations like leaf water potential (LWP) and higher turgor potential which led to higher rate of photosynthesis due to more opening of stomata for longer period of time. This could have increased or faster cell division and enlargement, which leads to higher growth and hence resulting in early reproductive phase. Similar findings were also reported by Keerthi *et al*. (2017).

Among nutrient management treatments, crop fertilized with recommended dose of fertilizers recorded significantly higher number of plants per meter row length, lesser days to achieve 50% flowering and took lesser duration to attain physiological maturity which was at par with the treatment in which natural farming practices were adopted along with the application of 10t FYM/ha as well as with organic farming treatment. Further, it was found that treatments *viz*., natural farming with 7.5t FYM/ha and natural farming with 5t FYM/ha package were at par with each other. However, significantly lowest emergence count per meter row length, and maximum days taken to 50% flowering and maximum duration to achieve physiological maturity was recorded in natural farming because of inadequate supply of nutrients for proper growth and development. The treatments in which FYM was added at a higher rate i.e. 10t FYM/ha or 7.5t FYM/ha with natural farming practices or organic farming treatment where FYM was applied at 15t FYM/ha, gave significantly higher emergence count and lesser days to 50% flowering and lesser days taken to physiological maturity. All the growth and development parameter/attributes of Indian mustard increased with increasing levels of nutrients. This might be due to the fact that nitrogen being the basic constituent of chlorophyll, protein and cellulose required for the process of photosynthesis and tissue formation for proper growth and thereby advancing the phonological stages of crops and increasing the yield attributes. Keerthi *et al*. (2017) also reported similar results.

Seed yield (kg/ha), Stover yield (kg/ha) and Biological yield (kg/ha)

It is evident from data presented in table 4 that yield of mustard was significantly influenced by different dates of sowing and nutrient management practices. Among different dates of sowing significantly higher seed yield (1094.7 kg/ha), higher stover yield (3257.4 kg/ha) and higher biological yield (4352.1 kg/ha) was obtained from early sown crop (11th October) as compared to late sown crop (26th October). Higher temperature during later part of the crop growth in delayed sowing and longer reproductive phase in early sowing might have made this difference in seed yield. Delayed sowing recorded lower branches per plant, less dry matter weight, lower test weight, less number of siliquae per plant and ultimately resulted in lower seed yield. These findings are in conformity with those of Rajput *et al*. (1991). The higher stover yield obtained in early sown crop might be due to prolonged growth period which resulted in higher number of leaves per plant and leaf area, and consequently more dry matter accumulation. With delay in sowing biological yield was significantly reduced due to less time availability to utilize the available resources. Similar findings were also reported by Walton *et al*. (2011).

Among nutrient management treatments, significantly higher seed yield (1176.7 kg/ha), stover yield (3410.5 kg/ha) and higher biological yield (4587.2 kg/ha) was recorded when crop fertilized with recommended dose of fertilizers which was followed by natural farming practices along with 10 t FYM/ha, organic farming package and natural farming with 7.5 t FYM/ha, the latter three being at par with each other, Significantly lowest seed yield (878.6 kg/ha), lowest stover yield (2696.9 kg/ha) and lowest biological yield (3575.5 kg/ha) was recorded in natural farming treatment. Application of recommended dose of chemical fertilizers resulted in higher seed yield, higher stover yield and higher biological yield over organic farming package, natural farming alone, natural farming + 5 t FYM/ha, natural farming + 7.5 t

FYM/ha and natural farming + 10 t FYM/ha treatments respectively. This was due to the inability of the practices adopted in natural farming treatment to meet out the nutrient requirement of mustard crop adequately. The treatments in which FYM was added at a higher rate i.e., 10 t FYM/ha, 7.5 t FYM/ha with natural farming, or organic farming treatment in which 15 t FYM/ha was applied and gave significantly higher yield as the greater part of the nutrient requirement of the crop was met through the addition of FYM. Treatment in which lower dose of FYM was added resulted in lower yield.

The highest yield recorded with the application of recommended dose of fertilizers could be attributed to the availability of nutrients in adequate amounts applied through chemical fertilizers. These results are in conformity with findings of Lepcha *et al*. (2015) and Reddy and Singh (2018).The higher biological yield was significantly associated with higher seed and stover yield of mustard. This clearly shows the biological yield increased by any input or management practice will automatically increased the seed and biological yield of mustard. Similar results have been reported by Keivanrad and Zandi (2012) and Singh *et al*. (2014).

Conflicts of interest: Authors declare that no conflicts of interest exist.

Table 1. Effect of treatments on plant height (cm) of Indian mustard

Treatment	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	At Harvest
Sowing Dates						
11th October	9.7	38.4	121.7	140.6	144.9	145.7
26th October	8.0	33.9	118.6	135.4	139.8	140.0
SE(m)±	0.2	0.7	1.0	1.6	1.7	1.7
CD (P=0.05)	0.6	2.1	3.1	4.8	4.9	4.9
Nutrient Management						
RDF (60:40:40)	10.6	44.4	128.9	151.6	158.6	159.1
Organic Farming package	9.1	37.0	120.9	141.9	144.2	144.6
Natural Farming	7.2	28.7	111.3	125.4	126.7	127.3
Natural Farming + 5t FYM	7.5	31.9	116.5	130.9	132.0	132.6
Natural Farming + 7.5t FYM	8.8	34.7	119.0	134.2	139.2	139.7
Natural Farming + 10t FYM	9.9	40.3	124.6	144.2	153.5	153.8
SE(m)±	0.3	1.2	1.8	2.8	2.9	2.9
CD (P=0.05)	1.0	3.6	5.4	8.4	8.6	8.5

Table 2. Effect of treatments on dry matter accumulation (g/m^2) of Indian mustard

Treatment	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	At Harvest
Sowing Dates						
11th October	47.1	107.2	282.2	363.9	439.9	445.6
26th October	45.7	99.3	274.3	349.6	399.8	401.1
SE(m)±	1.2	2.7	2.7	4.9	3.5	3.6
CD(P=0.05)	NS	8.0	8.0	14.4	10.4	10.5
Nutrient Management						
RDF (60:40:40)	52.9	120.6	295.6	403.9	481.1	484.2
Organic farming package	47.6	106.0	281.0	367.8	427.4	431.0
Natural Farming	39.8	83.9	258.9	309.7	360.0	364.2
Natural Farming + 5t FYM	42.0	94.9	269.9	330.2	399.2	403.4
Natural Farming + 7.5t FYM	46.1	101.6	276.6	347.5	411.9	415.2
Natural Farming + 10t FYM	50.0	112.5	287.5	381.7	439.5	442.3
SE(m)±	2.0	4.7	4.7	8.4	6.1	6.2
CD(P=0.05)	6.0	13.9	13.9	24.9	17.9	18.2

Table 3. Effect of treatments on emergence count per meter row length, days to 50% flowering, days taken to physiological maturity of Indian mustard

Treatment	Emergence count (No/m^2)	Days to 50% flowering	Days to Physiological maturity
Sowing Dates			
11th October	54.0	74.0	160.0
26th October	51.1	86.3	151.8
SE(m)±	0.9	0.8	1.1
CD (P=0.05)	2.8	2.4	3.3
Nutrient Management			
RDF (60:40:40)	58.7	76.2	149.8
Organic Farming package	54.2	78.3	153.8
Natural Farming	45.7	85.2	163.0
Natural Farming + 5t FYM	49.3	83.0	159.8
Natural Farming + 7.5t FYM	51.2	80.5	156.2
Natural Farming + 10t FYM	56.3	77.7	152.7
SE(m)±	1.7	1.4	1.9
CD (P=0.05)	4.9	4.1	5.8

Table 4. Effect of treatments on seed yield (kg/ha), biological yield (kg/ha) of Indian mustard

Treatment	Seed yield (kg/ha)	Biological yield (kg/ha)
Sowing Dates		
11th October	1094.7	4352.1
26th October	1015.2	3998.0
SE(m)±	6.8	21.6
CD (p=0.05)	19.9	63.3
Nutrient Management		
RDF (60:40:40)	1176.7	4587.2
Organic Farming package	1073.5	4308.2
Natural Farming	878.6	3575.5
Natural Farming + 5t FYM	1038.8	4011.9
Natural Farming + 7.5t FYM	1067.5	4178.5
Natural Farming + 10t FYM	1094.5	4388.9
SE(m)±	11.8	37.4
CD (P=0.05)	34.6	109.7

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