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Maximization of growth, seed yield and quality by adjusting date of sowing and nutrient level in mustard. (*Brassica juncea* Czern & Coss)

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Abstract
First date of sowing i.e. 5th November 2014 (D_1) was significantly superior for most of the growth, seed yield and quality parameters as it showed percent increase of 35.04 in no. of siliquae/plant, 32.11 in no. of seeds per siliqua, 14.40 in seed yield q/ha, 2.58 in seed recovery, 9.64 in oil content, 5.78 in germination, 8.01 in seed vigour index-I and 10.12 in seed vigour index-II over second date of sowing i.e. 18th November 2014. Treatment with T_7 (RNPKS ie. 60:40:40NPK + 40kgS + 25 kg /ha ZnSO4 + 5 kg/ha FeSO4) was found significantly effective for getting highest yield (19.73 q/ha), highest no. of secondary branches (14.75), germination (75.41%), shoot length (9.22cm) and root length (7.11cm) as well as for quality, having highest oil content (33.37%) vigour Index–I (1528.21) and vigour Index-II (11.34). Interaction of D_1xT_7 also exhibited significantly highest seed yield (21.30q/ha) and no. of secondary branches (17.25). Maximum seed yield and quality can be achieved by sowing of treated seed with carbendazim @ 2g./kg in first week of November with nutrient application of RNPKS i.e. 60:40:40 and 40 kg S + 25 kg ZnSO4 + 5kg FeSO4/ha.

Keywords: mustard, date of sowing and nutrient level

Introduction
Brassica (rapeseed-mustard) is the second most important edible oilseed crop in India after groundnut and accounts for nearly 30% of the total oilseeds produced in the country. When compared to other edible oils, the rapeseed/mustard oil has the lowest amount of harmful saturated fatty acids. It also contains adequate amounts of the two essential fatty acids i.e. linoleic and linolenic, which are not present in any of the other edible oils (Husain and Kumar 2006) [3].

To get appreciable good performance of cultivar, optimum time of sowing is very important because, seed as well as oil yield of rapeseed and mustard are greatly influenced by the variation in atmospheric temperature, humidity and other biotic factors (Husain and Kumar 2006) [3].

Plant growth, seed yield and yield attributing parameters are significantly influenced by sowing dates of mustard (Kumar *et al.* 2008) [4] and application of balance fertilizer is also a key factor of oilseed production technologies. Nutrients most often recommended for successful oilseeds farming are Nitrogen (N), Phosphorus (P), Potassium (K), Sulphur (S), Zinc (Zn) and Boron (B). Sulphur is generally called the fourth major nutrient after NPK because generally requirement of sulphur just slightly less than the potassium (Bala *et al.* 2011) [1].

High crop yield in agriculturally progressive districts of India, removed substational amounts of micronutrients especially zinc from soil, causing yield reduction (Deb and Sakal, 2002) [2]. Zinc deficient soil can be found throughout the world and are normally associated with low soil organic matter and alkaline soil (Yeganeh *et al.* 2012) [9].

Sulphur plays direct and prominent role in fatty acid synthesis. In oleiferous brassicas, it is required in the formation of flavouring compounds known as glucosinolates. It is the constituent of amino acids viz. cysteine and methionine (Marschner, 1995) [6]. It is also required for the synthesis of chlorophyll and vitamins like biotin and thiamine. The glucosinate content, an important quality parameter of rapeseed oil is increased with the sulphur application (Nuttal *et al.*, 1987) [7].

Iron is critical for chlorophyll formation and photosynthesis. Chlorophyll is the small “sun-panels” which the plants use to harvest energy from the sun and gives plants green pigment. Photosynthesis is the process during which the actual sun- rays are harvested.

Iron is also used by enzymes to regulate transpiration in plants. This transpiration process allows nutrients to reach all parts of the plants. Without iron the above functions would not work. Since, these functions are essential for plant growth, so there is a need to focus on these nutrients, especially zinc, as it is one of the most important micronutrient, while, applying with iron and NPK (Kumar *et al.*, 2014) [5].

The present investigation is, therefore, planned to find out the most appropriate sowing date and level of nutrients to get maximum seed yield and quality of mustard.

Materials and Method

The experiment was conducted in Rabi 2014-15 at New Dairy Farm, Kalyanpur of C.S.A.U.A & T. Kanpur. The experimental material for the present study was a single Variety of mustard i.e. Basanti (B/S) and were sown on two different dates i.e. Ist week of November (D_1) and IIIrd week of November (D_2). For both, 8 nutrient levels were applied viz. T_1: NPK (60:40:40 kg/ha), T_2: NPK+ recommended dose of sulphur (40 kg/ha), T_3:NPK+S (RD) +$ZnSO_4$ (20 kg/ha), T_4: NPK +S (RD) + $ZnSO_4$ (25kg/ha), T_5:NPK+ S (RD) + $ZnSO_4$ (20 kg/ha) + $FeSO_4$ (5 kg/ha), T_6: NPK +S (RD)+ $ZnSO_4$ (20kg/ha) + $FeSO_4$ (10kg/ha), T_7: NPK+S (RD) + $ZnSO_4$ (25 kg/ha) + $FeSO_4$ (5kg /ha) and T_8: NPK+S (RD) + $ZnSO_4$ (25 kg/ha)+ $FeSO_4$ (10kg/ha). Before sowing, seeds were treated with carbendazim @ 2g./kg seed. The experiment is laid out in Split Plot Design with 8 treatments. Each treatment is grown in a plot of 9 m. sq. area in four replications. Observations were recorded i.e. plant height (cm.), days to 50% flowering, no. of secondary branches plant^{-1}, no. of siliquae plant^{-1}, no. of seeds siliqua^{-1}, seed yield (q/ha), seed recovery (%), 1000 seed weight (g.), standard germination(%), seed vigour index–I, seed vigour index–II and oil content(%). Nutrient status of field before sowing and after harvesting were 8.30 (Basic) & 7.33 (Basic) pH, 0.42% & 0.66% (Medium) O.C., 16.0 Kg/ha (Medium) & 20.0 Kg/ha (Medium) P, 174.0 Kg/ha (Medium) & 227.0 Kg/ha (Medium) K, 9.2 Kg/ha (Low) & 8.75.0 Kg/ha (Low) S, 1.0 Kg/ha (Low) & 0.8 Kg/ha (Low) Zn, 2.4 Kg/ha (Normal) & 1.5 Kg/ha (Normal) Cu and 11.5 Kg/ha (Normal) & 10.9 Kg/ha (Normal) Fe, respectively.

Result and Discussion

Effect of dates of sowing, nutrient levels and their interaction analysis at CD (5%) for various parameters and means were presented table- 1.

Effect of date of sowings (D)

Significant influence of two dates of sowing i.e. D_1(Ist week of November) and D_2 (IIIrd week of November) was exhibited on days to 50% flowering, no. of silquae plant^{-1}, no. of seeds silqua^{-1}, seed yield, seed recovery, and on various seed quality parameters like oil content, 1000 seed weight, germination, vigour index-I and II. Days of 50% flowering significantly enhanced in D_2 (IIIrd week of November) by 7 days from D_1 whereas plant height was 170.80cm in Ist date of sowing and 139.83cm in IInd date of sowing and both were significantly different. It is cleared from observed data that Ist week of November sowing was more appropriate to get better plant growth. Similar findings were obtained by Kumar *et al.* (2008) [4] and Yeganeh *et al.* (2012) [9].

First week of November sowing significantly enhanced no. of secondary branches plant^{-1}, no. of siliqua plant^{-1}, no. of seeds siliqua^{-1}, seed yield q/ha, seed recovery %, by 47.06, 35.04, 32.11, 14.39, and 2.57% over II date of sowing, respectively. Apart from yield related parameters, seed quality was also improved significantly in terms of oil content, 1000 seed weight, germination, seed vigour index-I and seed vigour index-II in 1st week of November sowing and showed percent improvement of 9.64, 6.20, 5.77, 8.01 and 10.12, respectively, than II date of sowing i.e. III week of November. Similar findings were reported by Hussain and Kumar, 2006, Pooran *et al.* 2000, Kumar *et al*. 2008 [3, 8, 4].

It is cleared from observations that in changing scenario of climate the atmospheric temperature higher in month of October due to this early November sowing was found best for getting higher seed yield and quality (Bala *et al*. 2011) [1]

Effect of nutrient levels (T)

Various nutrients levels i.e. T_1: NPK (60:40:40 kg/ha), T_2: NPK+ recommended dose of sulphur (40 kg/ha), T_3: NPK+S (RD) +$ZnSO_4$ (20 kg/ha), T_4: NPK +S (RD) + $ZnSO_4$ (25kg/ha), T5:NPK+ S (RD) + $ZnSO_4$ (20 kg/ha) + $FeSO_4$ (5 kg/ha), T_6: NPK +S (RD)+ $ZnSO_4$ (20kg/ha) + $FeSO_4$ (10kg/ha), T7: NPK+S (RD) + $ZnSO_4$ (25 kg/ha) + $FeSO_4$ (5kg /ha) and T_8: NPK+S (RD) + $ZnSO_4$ (25 kg/ha)+ $FeSO_4$ (10kg/ha) showed significant influence on plant height, no. of secondary branches, no. of siliquae plant^{-1}, no. of seeds siliqua^{-1}, seed yield q/ha, as well as on seed quality parameters like seed recovery, oil content, vigour index-I and II whereas 1000 seed weight and germination were not influenced by applied nutrient levels.

Shortest plant height was observed in nutrient level T_1: NPK (60:40:40 kg/ha) i.e. 152.81 cm. whereas all other levels of nutrients significantly improved plant height i.e. 155.05 cm. in T_2, 154.88 cm. in T_3, 154.88 cm. in T_4, 154.88 cm. in T_5, 154.88 cm. in T_6, 154.88 cm. in T_7, and 154.88 cm. in T_8.

Application of nutrient level T_7 NPK+S (RD) + $ZnSO_4$ (25 kg/ha) + $FeSO_4$ (5kg /ha) exhibited significantly highest values of no. of secondary branches (14.75), no. of siliquae plant^{-1} (370.88), no. of seeds siliqua^{-1} (10.50) and seed yield q/ha (19.73) as well as for seed recovery (95.32%) and oil content (33.37%). Nutrient level of T_8 i.e. NPK+S (RD) + $ZnSO_4$ (25 kg/ha)+ $FeSO_4$ (10kg/ha) showed significantly similar performance to T_7 for no. of secondary branches, no. of siliquae plant-^{1}, seed recovery and oil content with values of 13.62, 365.12, 95.49% and 32.12% respectively, but seed yield q/ha and vigour index–I & II reduced significantly in T_8 level of nutrient application and reduction was 1.06 q/ha in seed yield, 94.05 in seed vigour index-I and 0.982 in seed vigour index-II.

Effect of nutrient levels on 1000 seed weight and germination was non significant but numerically highest values were observed in T_7 i.e. 3.30g and 75.41% respectively. These results were supported by various scientists (Nuttal *et al.* 1987, Marschner 1995, Deb and Sakal, 2002 and Kumar *et al*. 2014) [7, 6, 2, 5].

Effect of interaction (DxT)

Interaction of DxT was found significant for plant height, no. of secondary branches, seed yield q/ha, seed recovery. Regarding plant height, combination of D_1xT_8, D_1xT_7, D_1xT_6, D_1xT_4 and D_1xT_3 showed significantly higher plant height i.e. 173.80, 172.02, 170.95, 172.30 and 170.87 cm. By perusal of data it was cleared that D_1 i.e. I, week of November sowing with various level of nutrients have better impact on vegetative growth. Interaction of D_1xT_7 i.e. I week of Nov. sowing x T_7 i.e. NPKS i.e. 60:40:40:40 kg + 25 kg $ZnSO_4$ + 5kg $FeSO_4$ per hectare exhibited significantly highest no. of secondary branches (17.25) and seed yield q/ha (21.30) but

for no. of secondary branches D_1xT_8 showed at par performance to D_1xT_7 with value of 16.50. Treatment combination of D_1xT_8 also exhibited significantly highest seed recovery but in III week of Nov. sowing (D_2), treatment T_7 showed better performance than T_8.

From the above findings it may be concluded that maximum seed yield and quality can be achieved when carbendazim (2 g/kg) treated seeds were sown in Ist week of Nov. and by nutrient application of recommended dose of NPKS i.e. 60:40:40:40 kg + 25 kg $ZnSO_4$ + 5kg $FeSO_4$ per hectare.

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