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The result of the investigation entitled "Effect of sowing dates, planting geometry and varieties on growth, yield and quality of mustard (Brassica juncea coss). under irrigated conditions of Bundelkhand in U.P was embodied in the previous chapter. An attempt has been made to interpret and explain these findings with a view to understand the 'Cause' and 'Effect' relationship among growth, yield, quality and economics of the crop. The experimental findings has been discussed under the following heads:

WEATHER EFFECT:

Geographically the experimental station is located in southern U.P in Bundelkhand region. The experimental crop received 8.0 and $26.6$ mm rains during 2003-04 and 2004-05 respectively. It first year rains occurred twice in January and March in 1st and 2nd years. Thus, winter rains during second year benefited crop more than first year. The minimum temperature during crop period gone down to 3.9 and 5.2°C while maximum temperature rise 37.5°C and 35.03°C during first and second year respectively. The evaporation rate was recorded between 1.1 to and 1.8 to 6.2mm/day during both the years. The minimum during January was comparatively lesser than the second year of study. It might have affected up to some extent the growth of experimental crop in that particular period.
which was exhibited in yield and general performance of crop in the year. Otherwise the experimental crop availed similar atmosphere during two years of experimentation.

**EFFECT OF SOWING DATES:**

The optimum time of sowing for a particular crop and their variety under agro-climatic condition on a tract have great importance than other agro techniques and inputs under available resources for producing maximum and economic yield of the crop.

**EFFECT ON GROWTH PHENOLOGY:**

The growth of the crop is determined by height of plant, fresh and dry weight/plant and their shoots per plant. The examination of the table (7 to 14) that all the growth characters such as height of main shoot, number of functional leaves/plant, leaf area, fresh and dry weight/plant and number of primary, secondary and tertiary branches per plant were recorded significantly maximum in sowing date 25 October (D2) followed by 10 October (D1) and 10 November sowing dates, respectively. The days of 50% flowering and 50% maturity were also more in 25 October (D2) sowing date. The more growth in 25 October (D2) sowing date was found due to suitable growth period and optimum agro climatic conditions for their growth and development of plant. Yadav et al. (1996), Singh et al. (2001) and Panda (2004) also reported that 2nd fortnight of October was the optimum time for sowing mustard crop. The early sowing in this tract, due to rise temperature was adversely affected to germination and
growth of the mustard crop. In delay sowing after 3rd and 4th weeks of October. The growth and development of plant was reduced due to short growing period and sudden dropping temperature during the grant growth period. The results were conformity with the findings of Bisnoi and Singh (1979), Narang and Singh (1987), Jadav and Singh (1992) and Yadav et al. (1996).

**EFFECT ON YIELD ATTRIBUTES AND YIELD:**

Reference to table (15 to 16) that yield contributing characters such as number of siliqueae/plant, weight of siliqueae/seed, length of siliqueae, number of siliquea, weight of seeds/siliqueae and weight of seeds/seed were found maximum in 25 October (D_2) sowing date followed by 10 October (D_1) and 10 November (D_3) sowing dates, respectively. It is due to optimum sowing time and favourable climatic conditions for mustard crop. Patel et al. (1980), Jadav and Singh (1992), Yadav et al. (1994) and Panda et al. (2004) were also reported same results.

In respect to seed yield in q/ha, the seed weight/seed and their attributes are responsible for it. The examination of results given in table (17) showed that 25 October (D_2) sowing date produced significantly maximum seed yield (q/ha) in both the years and pooled value recorded 8.19 and 9.84 percent more seed yield (q/ha) over 10 October (D_1) and 10 November (D_3) sowing dates, respectively. The same trend was also observed in yield attributes as number and weight of siliqueae/seed, length of siliqueae, number of seeds and weight of seeds/siliquea and weight
of seeds/plant. The above all yield contributing characters were enhanced and pushed for increasing seed yield in q/ha in 25 October (D$_2$) sowing date. The seed yield in respective sowing date was maximum due to optimum time for growth period better climatic conditions during flowering and more fruiting of plants. The results were conformity with the findings of Patel et al (1980), Singh (1985), Jadav and Singh (1992), Yadav et al. (1996), Batter and Aulakh (1999), Singh et al (2001) and Panda et al. (2004).

EFFECT OF SOWING DATES ON GROWTH YIELD ATTRIBUTES AND YIELD:

The data presented in table 7 to 14 clearly indicate that all round improvement on growth characters such as height of main shoot, number of functional leaves/plant, leaf area, fresh and dry weight/plant, number of primary, secondary and tertiary branches/plant were found significantly maximum in sowing date 25 October (D$_2$). The days to 50%, flowering and 50% maturity were also significantly more in respective date of sowing in both the years and mean value also. The more number of leaves/plant and leaf area increased more photosynthesis and accumulation of assimilates for longer period improved the growth development and dry matter production/plant in respective sowing date (25 October) due to optimum sowing time and favourable climatic conditions especially temperature. In respect to yield attributes (Table 15 to 16), such as number and weight of siliquae/plant, length of siliquae, number of seeds and weight of
seeds/siliquae, weight of seeds/plant and weight of 1000 seeds were also found maximum in 25 October (D2) sowing date over other dates of sowing in both the years. The more growth and development especially dry matter accumulation/plant and number of branches/plant were push to increase yield attributes and seed weight/plant. This might be due to more favourable climatic conditions in respect to growth, development and transformation of food materials for longer period to reproductive parts, hence increase to growth parameters and yield attributes. The above all growth, development and yield contributing characters were positively pushed and enhanced to increase biomass production and seed yield in q/ha in 25 October (D2) sowing date over early and late dates of sowing table (17). The results are similar to those obtained by Patel et al. (1980), Singh (1985), Yadav and Singh (1992), Yadav et al. (1996), Singh et al. (2001) and Panda et al. (2004).

EFFECT OF SEED QUALITY:

The presented table (18) showed that 1000 seed weight, percent oil and protein content were significantly affected due to dates of sowing in two years data. The 25 October (D2) sowing date increased significantly maximum oil and protein content in both years and mean value also over other dates of sowing. This may be due to long duration for growth and reproductive phase, favourable weather conditions and bold seed size, Narang and Singh (1987), Kurmi and Kalita (1991), Panda et al. (2004) were
also reported that early sowing increase seed size/oil and protein content than late sown crop

**EFFECT OF PLANTING GEOMETRIES:**

The optimum plant population or planting space in the most important factor for a particular crop for increasing the yield in per unit area than other growth and yield deciding factors and agro techniques.

**EFFECT ON GROWTH PHENOLOGY:**

Reference to table (7 to 14) clearly showed that all round improvement in various growth characters were positively influenced with increasing planting geometries in both the years. The examination of the results in respect to growth parameters such as height of main shoot, number of functional leaves/plant, leaf area, fresh and dry weight/plant and number of primary, secondary and tertiary branches/plant were significantly affected by different planting geometries. The above all growth characters were recorded maximum in planting geometry 60x15 cm(G3) followed by 45x15 cm (G2) and 30x15 cm (G1) planting geometries, respectively in both the years.

The dry matter accumulation/plant is the positive response of plant growth and development. In this reference, table (12) revealed that planting geometry 60x15 cm (G3) increased maximum dry matter/plant in different stages of growth in both the years and the final observation i.e. at harvest. On mean value base, it increased 1.76 and 4.75 percent more dry weight/plant over 45x15 cm(G2) and 30x15 cm(G1) planting.
geometries, respectively. The maximum dry matter production/plant in wider planting geometry is due to more utilization of sunlight, soil nutrient, soil moisture to individual plant and minimum competition effect between the plants, results more transformation of photosynthetizes for development and growth. In this connection, the growth and development characters, duration of 50% flowering and 50% maturity were maximum in respective planting geometry 60x15 cm (G3) followed by others. The same results were reported by Vir and Verma (1980), Singh and Singh (1987), Mishra and Rama (1992), Singh and Chauhan (2000), Mahan and Singh (2003) and Singh and Ram (2005).

**EFFECT ON YIELD ATTRIBUTES AND YIELD:**

A differential response of planting was observed in respect to yield attributes and yield. In Table (15 and 16) it is clearly showed that all the yield contributing characters such as number of siliquae/plant, weight of siliquae/plant, length of siliqua, Number of seeds/siliqua, weight of seeds/siliqua and weight of seeds/plant were found maximum in planting geometry 60x15 cm (G3) over other plant spaces. The per plant seed weight and their attributes were increased maximum in planting geometry 60x15 cm (G3) due to more exposure of plant in sunlight, more utilization of soil moisture and nutrients, more transformation of photosynthetizes for reproductive parts and minimum composition and shading effect among the plants. Vir and Verma (1980), Singh and Singh (1987), Chauhan et al.
(1993), Singh (1994), Singh and Chauhan (2000), Måhan and Singh (2003) were also reported similar results.

In respect to seed yield (q/ha) table (17) showed that significantly maximum seed yield (q/ha) was recorded in planting geometry 45x15 cm (G2) in both the years. The pooled value was 3.82 and 5.86 percent more over 30x15 cm (G1) and 60x15 cm (G3) planting geometries, respectively. The seed yield in q/ha is the resultant of number of plants/unit area, weight of seeds/plant and their yield contributing characters as number and weight of siliquae/plant, length and number of seeds/silique. Though the per plant seed weight and their yield attributes were recorded maximum in wider planting geometry 60x15 cm (G3) but number of plants/unit area was minimum, therefore, biomass production and seed yield in per unit area did not compensate to optimum planting geometry i.e. 45x15 cm (G2) and reduced seed yield. The results were conformity with the findings of Vir and Verma (1980), Singh and Singh (1987), Singh (1994), Singh and Chauhan (2000) and Singh and Ram (2005). In closer planting geometry i.e. 30x15 cm (G1), the total number of plants/unit area was maximum but due to moderate plant population/unit area was not developed properly due to competition effect between plants and did not cover seed yield (q/ha) over the planting geometry 45x15 cm (G2). Due to optimum plants/unit area and proper development of plants in 45x15 cm (G2) planting space increased biomass production and seed yield in q/ha.
EFFECT OF GROWTH, YIELD ATTRIBUTES AND YIELD:

The maximum dry matter production/plant is the positive effect of growth characters such as height of main shoot, number of functional leaves/plant, Leaf area and number of branches/plant because, in wider planting geometry, the plant utilized more soil sources, more exposure of plant in sunlight to increase photosynthetic activity and accumulate food material in the plant. In this fact, the growth and development to the plant was increased which finally increased dry matter production in plant. The growth and development of plant pushed for increasing yield attributes and finally weight of seeds/plant. The above growth and yield characters were found maximum in 60x15 cm (G3) planting geometry followed by other planting geometries. Though the growth and yield parameters were enhances and pushes to increase seed yield (q/ha) and biomass production. But due to minimum plants/unit area in 60x15cm (G3) planting geometry could not compensate to cover seed yield and biomass production in q/ha as compare to optimum plant population. Therefore, seed yield and biomass production in q/ha was maximum in 45x15 cm (G2) planting geometry. The similar results were also reported by Vir and Verma (1980), Singh and Singh (1987), Chauhan et al. (1993), Singh and Chauhan (2000), Mohan and Singh (2003) and Singh and Ram (2005).

EFFECT ON SEED QUALITY:

Among quality parameters, percent oil content and protein content in seed were significantly influenced by different
planting geometries in both the years data (Table 18). The above quality parameters data were recorded significantly maximum in wider planting geometry 60x15cm (G₃) followed by other plant spaces. It may be explained that in wider plant spaces take more nutrients and synthesized more assimilates at a similar rate and proportion which produced bold seed size under wider planting geometry.

**PERFORMANCE OF VARIETIES:**

Varieties of any crop be have differently response from each other even when they are grown in similar atmosphere. The behaviour of those depends upon their genetic constitution. Their requirements of inputs for exploiting yield potential may vary when they are cultivated under same situation and atmosphere. The performance of mustard varieties tested in the present study is being discussed here.

**EFFECT ON GROWTH PHENOLOGY:**

It is evident from table (7 to 14) that different growth characters such as height of main shoot, number of functional leaves/plant, leaf area, fresh and dry weight/plant, number of primary, secondary and tertiary branches/plant, days to 50% flowering and 50% maturity were found maximum in variety Pusa bold (V₂) followed by the varieties Jagannath (V₃) and Varuna (V₁) respectively in both the years. The maximum dry matter production and more number of branches/plant in variety Pusa bold (V₂) indicate more development and growth of plant over other varieties. Gurjar and Chauhan (1997) Singh et al. (2001)
Veerya and Singh (2003) and Panda et al. (2004) also reported same results.

**EFFECT ON YIELD ATTRIBUTES AND YIELD:**

The seed yield is the past time response of number of plants/unit area weight of seeds/plant, number of branches/plant and yield contributing characters of the plant. The examination of the results given in table (17) showed that the seed yield (q/ha) was significantly maximum in variety Pusa bold (V₂) and pooled value was 12.50 and 21.69 percent additional in comparison to the varieties Jagannath (V₃) and Varuna (V₁) respectively. The same trend was also observed in weight of seeds/plant and their yield contributing characters such as number and weight of siliqua/plant, length of siliqua, number and weight of seeds/siliqua. Gurjar and Chauhan (1997), Singh (2001) Veerya and Singh (2003) and Panda et al. (2004) were also reported the superiority of Pusa bold variety in seed yield over other tested varieties.

**EFFECT ON GROWTH CHARACTERS, YIELD ATTRIBUTES AND YIELD:**

The growth characters especially dry matter production per plant and number of different branches/plant indicate more development and spreading of plant. In other hand, more growth, development and number of branches/plant increased more number of siliqua/plant, weight of siliqua/plant and weight of seeds/plant. The examination of the table (7 to 14) that maximum growth and development and main
yield contributing characters such as dry weight/plant, number of primary, secondary and tertiary branches plant, number and weight of silique/plant and weight of seeds/plant were recorded in variety Pusa bold (V₂) over other varieties of mustard in existing agro climatic condition. The more growth development of plant and per plant main yield deciding characters were jointly increased maximum seed yield in q/ha. In this connection, the variety Pusa bold (V₂) produced significantly maximum seed yield and biomass production in q/ha in both the years and pooled value also over other tested varieties. The results were conformity with the findings of Gurjar and Chauhan (1997), Singh (2001), V ārya and Singh (2003) and Panda et al (2004).

EFFECT ON SEED QUALITY:

The presented table (18) clearly indicated that weight of 1000 seeds, percent oil and percent protein content in seed of mustard in both the years was recorded maximum in Pusa bold (V₂) variety and same trend was also observed in mean value of two years data. It is due to genetic characters to the variety.

INTERACTION EFFECT BETWEEN DATES OF SOWING AND PLANTING GEOMETRIES (DxG):

The interaction effect between DxG in growth characters such as height of main shoot at harvest, number of functional leaves/plant at 60 days, fresh weight/plant at 90 days in both years and at harvest in 2004-05 years, dry weight/plant at 90 and at harvest in both years, number of secondary and tertiary branches/plant in 2004-05 year, days of 50% flowering
in both years, yield attributes such as number of siliquae/plant, weight of siliquae/plant in 2004-05, Length of siliqua in 2003-04, Number of seeds/siliqua, weight of seeds/plant and percent oil content in both years were recorded significantly maximum in D$_2$G$_3$ interaction followed by other interactions of sowing dates and planting geometries in both years data. The separate improvement in sowing date D$_2$ (25 October) and planting geometry G$_3$ (60x15 cm) produced the maximum growth characters resulting higher yield attributes. It is due to optimum sowing time and more space between plants and more utilization of soil and atmospheric resources. Yadav and Singh (1992), Yadav et al. (1996) and Panda et al. (2004) also reported that 3$^{rd}$ and 4$^{th}$ weeks of October sowing time and Vir and Verma (1980), Singh and Singh (1987), Chauhan et al. (1993), Singh and Chauhan (2000) and Mahan and Singh (2003) also reported that wider planting space increased maximum growth and yield characters in mustard.

The biomass production in both the years was significantly maximum in D$_2$G$_2$ interaction though the growth and yield attributes were maximum in D$_2$G$_3$ interactions. It might due to proper time for germination and long vegetative phase in respective sowing date and optimum plant population in per unit area basis. In jointly the D$_2$G$_2$ combination produced maximum total biomass production and seed yield in q/ha. Patel et al. (1980), Jadav and Singh (1992), Yadav et al. (1994), Yadav et al. (1996) and Panda et al. (2004) in sowing time and Vir and Verma.
(1980), Singh and Chauhan (2000), Mahan and Singh (2003) Singh and Ram (2005) in planting spaces were also reported same results.

**INTERACTION EFFECT BETWEEN DATES OF SOWING AND VARIETIES (DxV):**

The interaction effect on height of main shoot, number of functional leaves/plant at 60 days, fresh weight/plant at 90 days, dry weight/plant at harvest in 2004-05, days of 50% flowering in both years, days of 50% maturity in 2004-05, number of siliquae per plant, weight of siliquae/plat in both years, weight of seeds per plant in 2004-05, total biomass production (q/ha) and harvest index in both years, were recorded significantly maximum in D$_2$V$_2$ interaction followed by other interactions of dates of sowing and varieties. It may be due to optimum time for a germination and long growth period for crop and genetical characters of variety The Jadav and Singh (1992), Yadav et al (1996) were reported more growth characters, yield attributes and Yield in 3rd and 4th weeks of October sowing date and Gurjar and Chauhan (1997), Singh et al. (2001), Panda et al. (2003) were reported the superiority of Pusa bold variety.

**INTERACTION EFFECT BETWEEN PLANTING GEOMETRIES AND VARIETIES (GxV):**

The interaction G$_3$V$_2$ was found superior due to separate superiority of G$_3$ (60x15 cm) planting geometry and V$_2$ (Pusa bold) variety in growth characters and yield attributes. The interaction effect to growth characters, such as height of main
shoot in 2004-2005 year, number of functional leaves/plant at 60 days in both years data, fresh weight/plant and dry weight/plant at 90 days in 2004-05, number of siliquae/plant in 2004-05 were recorded significantly maximum in G$_3$V$_2$ interaction over other interactions of planting geometries and varieties. It might be due to wider space between plants and more utilization of soil resources and minimum composition between plants and superiority to variety. The stover yield (q/ha) and harvest index in both years and percent protein content in 2004-05 were recorded significantly maximum in G$_2$V$_2$ interaction due to optimum plant population/unit area and proper development of plants. Vir and Verma (1980), Singh and Chauhan (2000), Mahan and Singh (2003) and Singh and Ram (2005) were also reported 45x15 cm plant spaces recorded maximum seed yield and biomass production in q/ha

**INTERACTION EFFECT BETWEEN DATES OF SOWING, PLANTING GEOMETRY AND VARIETIES (DxGxV):**

The interaction effect between DxGxV in increasing growth characters such as height of main shoot at harvest in 2004-05, number of functional leaves/plant at 60 days in both years, leaf area at 60 days in 2004-05 year, Fresh weight/plant at 90 days in both years, dry weight/plant at 90 days in 2004-05, days of 50% flowering in 2003-04, number of secondary branches/plant and days of 50% maturity in 2004-05 year, weight of siliquae/plant in both years, weight of seeds/plant in 2004-05 were recorded significantly maximum in D$_2$G$_3$V$_2$ interaction due to separate superiority of sowing date D$_2$ (25...
October), G3 (60x15 cm) and V2 (Pusa bold) in growth parameters and yield attributes. The total produce (q/ha), stover yield (q/ha) and harvest index in both years were recorded significantly maximum in D2G2V2 interaction due to separate improvement of respective sowing date planting geometry and variety. The same results were reported by Patel et al. (1980), Jadav and Singh (1992), Singh et al. (2001), Panda et al. (2004) in dates of sowing, Vir and Verma (1980), Singh and Singh (1987), Singh and Chauhan (2000), Mahan and Singh (2003) in planting spaces and Gurjar and Chauhan (1997), Singh et al. (2001), Varsha and Singh (2003) and Panda et al. (2004).

**EFFECT ON ECONOMICS:**

In farming business the economics have great importance to judge the best combination of input for getting maximum output. In this view, the economics was calculated and presented in table (19) and showed that maximum net returns (Rs/ha) mean value of two years are Rs 14853.27, Rs. 14209.97 and Rs. 16358.29/ha was calculated in sowing date 25 October (D2), planting geometry 45x15cm (G2) and variety Pusa bold (V2) respectively. The combined effect of D2G2V2 was also accrued maximum net profit Rs. 19436 07/ha over other dates of sowing, planting geometries and varieties. Form the net return base, the sowing date 25 October, planting geometry 45x15cm, and variety Pusa bold is the economic combination for mustard crop under the irrigated condition of Bundelkhand tract of U.P. It is mainly due to superior seed yield (q/ha) recorded under the respective combination.