Manuring.

Belgrave (8) observed that the application of nitrogen and phosphorus was useful for better growth and higher yield in corn. Black (9), Black et al (10), Cautheen & Williamson (15), Mooers (60), Pandelton (67) and Russel (72) obtained increased corn yields with the application of nitrogenous fertilizers like nitrate of soda or ammonium sulphate over the control. Bonnardant (11) and Fere (26) secured larger corn yields with compound commercial fertilizers than with compost or barn-yard manure.

Brooks (13) reported that nitrogen application in the form of nitrate of soda gave better results than the application of phosphoric acid and potash. Similar results were obtained at Texas and Nyasaland Agricultural Experimental Stations (6, 7) in the years 1949 and 1951 respectively, Fitts (25), Thorne & Hickman (80) and Williamson et al (87).

Crowther et al (19) compared close spacing of three holes per square meter with wide spacing of one hole per square meter under different manural doses, i.e., one sack, two sacks, and three sacks of nitrogenous fertilizer per feddan. Wide spacing gave no increase with the third sack, while close spacing gave an increase of 0.74 ardebs per feddan. The increase from manuring averaged for both spacings was 4.0 ardebs for the first sack, and another 2.3 ardebs for the second. With the third sack only close spacing gave increased yield. Application of nitrogen encouraged better development of ears and increased the leaf area but not the leaf number, and...
reduced the number of sterile plants.

Dumenil (30) recommended a final stand of 12000 stalks per acre on low fertility soils and 16000 stalks per acre on high fertility soils for the best utilization of the nitrogen fertilizer. He obtained an increased yield of 20 bushels per acre with 30 lbs. of nitrogen as compared to no-nitrogen plots. He stressed the need of application of higher doses of nitrogen, i.e., 120 lbs. to 130 lbs. nitrogen per acre, under thicker plantings for getting an increased yield. For all stands, there was a tendency for both the weight of ears and their number per stalk to increase with an increase in the dose of nitrogen.

Hinkle (38) noticed a tendency for the size and the number of ears to increase under increased levels of nitrogen for all spacings. He (29) later showed that moderate and heavy dressings of nitrogen brought about a phenomenal increase in corn yield. The greatest response to nitrogen was obtained with heavy planting rates. Nitrogen in excess of 120 lbs. per acre gave no additional response with 3000 plants per acre. But with a stand of 16000 plants, the yield was still increasing with 150 lbs. nitrogen per acre.

Krantz (40) secured average yields of 28, 53, 71 & 81 bushels per acre from plots receiving 0, 40, 80 & 120 lbs. of nitrogen respectively. Application of nitrogen increased both the size of ears and their number per plant and also markedly increased the protein content of corn grain. Krantz & Chandler (41) observed a marked increase in yield with the application of nitrogen. It had only a slight tendency to increase lodging, whereas it consistently increased the
nitrogen composition of corn grains. Krantz & Pearson (42) obtained 62 & 74 bushels per acre with 0 & 30 lbs. nitrogen application respectively with a stand of 5000 plants per acre. By increasing the stand to 9000 plants, the average yields were 80, 87 & 93 bushels with 30, 60 & 90 lbs. nitrogen per acre. Similar results were reported by Eskew & Palen (24) and Kerle (35).

Latta (44) found that stable manure had a more marked effect on corn yield than commercial fertilizers. Being a complete manure, it would benefit all classes of soil that need to be enriched. In a subsequent work, he (45) obtained increased yields with high grade fertilizer and horse manure although the immediate return did not cover the additional cost of the fertilizer.

McCready et al (54) obtained 114 bushels and 113 bushels yield of corn per acre from manure plus superphosphate plus 240 lbs. nitrogen per acre and 240 lbs. nitrogen per acre alone respectively on a fine sandy loam soil. Potash and manure had no effect on yield and manure plus superphosphate depressed the yield by 14 bushels per acre. Miller et al (56) found 17.8 lbs. per acre of nitrogen from ammonium sulphate to be the most suitable fertilizer application. Higher rates were found to be more efficacious when phosphorus was applied.

Mitchell (57) got an increased yield of corn by the frequent application of farmyard manure and 12 tons gave a better yield than 6 tons of the manure per acre.

Mo Vikar et al (55) found that on silt loam soils where P & K showed no response, 0, 60 & 120 lbs. nitrogen per
acre gave yields of 71.7, 100.0 and 106.3 bushels per acre respectively. On sandy loam soils the yield from 400 lbs. of 2-12-12 basic application was 51.9 bushels, but with an additional application of 92 lbs. of nitrogen per acre, the yield shot up to 104.3 bushels per acre.

Mooers (61) observed that a poor silt loam proved highly responsive to the application of nitrogen. He secured an increase of 12 bushels per acre in yield from the application of 100 lbs. of nitrate of soda. The increase from 120 lbs. & 160 lbs. of this fertilizer was 12.3 and 15.3 bushels per acre, respectively.

Nelson (63) obtained increased yields of corn by 31.4 and 40.7 bushels per acre with the application of 80 lbs. and 160 lbs. of nitrogen per acre over the no manure treatment. The protein content of the grain increased with each increment of the fertilizer.

Richey (68) reported that corn was a rich land crop and probably nothing would make for larger yields of corn as universally as the liberal application of well rotten manure.

Seem & Huber (73) suggested that higher doses of 10-10-10 fertilizer gave a higher corn yield under thick stands. Similar results were reported by Innes (35) and at the Mississippi Agricultural Experimental Station (5) during 1947.

The study of available literature reveals that very little systematic research work has been done in India on the manorial aspect of the crop. Manorial experiments were conducted at the Imperial Agricultural Research Institute, Pusa (4), during the years 1932 to 1935. The best results were
obtained from the combination of 4000 lbs. of farmyard manure and rape cake followed by rape cake and ammonium sulphate. There was practically no difference in the yields under potassium sulphate, superphosphate and the control. The results obtained at the Agricultural Experimental Station, Jullundur, during the years 1948 to 1951 showed that the application of nitrogenous fertilizer (ammonium sulphate) increased maize yields significantly over the control. The highest grain and stalk yields were recorded with 150 lbs. nitrogen per acre beyond which the application of nitrogen did not show any further increase in yield. Similar results were recorded by Luthra (51), Mann (52) and Sharma (75). They further noticed an all round improvement in plant and ear development of maize and reduction in the number of barren plants with the application of nitrogen. The manural experiments conducted at the Indian Agricultural Research Institute, New Delhi, (2), during the years 1949 to 1951 also showed that the application of 40 lbs. and 80 lbs. of nitrogen per acre in the form of ammonium sulphate gave significantly higher yields than the no-nitrogen plots in all the years. The response to phosphatic and potassic manures was negligible.

Spacing.

Conner (18) compared 3 feet and 6 feet row spacings keeping the same number of plants per acre i.e. 4840 in each case by sowing seeds 36 inches and 18 inches apart respectively, and noted an increase of 1.88 bushels per acre in favour of regular row spacing of 3 feet. Similar results were
also reported by Brandon (12), Collins & Shedd (17), Mitchell (57), Mooers (59), Olson (65), Sprague (76) and Zook and Burr (88).

Sisals (21) tried 1, 2, 3, 4 & 5 plants per 40 inch hill and found that the height of the corn plants was not appreciably influenced by the rate of planting. The leaf area and the number of ears per stalk increased with thin sowings as compared to thick plantings. The nitrogen content of the kernels was not materially affected by the rate of planting. Bryan et al (14) compared the normal spacing of 42"x42" with 21"x21" and several other closer spacings. The average yield of 21"x21" spacing in four years exceeded that of the 42"x42" spacing by 3.1 bushels per acre. Closer spacings were, however, found to have more lodged plants and fewer ears per 100 plants than the wider spacings. The shelling percentages did not differ significantly under the various spacings tried.

Innes (35) and Enzie (23) found that increased rate of planting increased the yield. Whereas the weight of grains per plant and the percentage of plants bearing two ears or more decreased. The height of the plants was not materially affected by the various plant spacings. Hulsedan (30) compared 42, 40, 38 & 36 inches row distances with 2, 3, 4 & 5 plants per hill on sweet corn and observed that the increased number of plants per hill had either a slight effect on height of

In the U.S.A. and most other foreign countries, there are generally two methods of sowing, viz, (i) drilling and (ii) hilling. Drilling means the planting of single kernels at uniform distances in rows of conventional width; while hilling of sowing in hills means the planting of a number of kernels in the corners of rectangles.
tended to increase it. The ears were better developed under wider spacings than the closer ones.

Engledow (22), Haber (27) and Hinkle (29) obtained higher grain yields from thicker than from thinner plantings. But the ear size and the average number of ears per plant decreased and the number of barren plants increased with an increase in the number of plants per foot.

Kisselbach et al (37) and (38) found that an average of 2 to 3 plants per hill, 3.5 feet apart, might be regarded as the most practical spacing for standard varieties of corn. Doubling the distance between rows to 7 feet under normal stand of plants, reduced the yield by 23 percent. Increased planting rates resulted in a striking increase in the percentage of barren plants and decrease in the percentage of two eared stalks. The differences in planting rates affected but slightly the stalks and ear height, the dates of silking and ripening and the shelling percentage.

Kohnke & Miles (39) tried 3930, 7860, 11791, 15721, 19651, 23381 & 27512 kernels per acre and obtained the highest corn yields with planting rates between 15,000 to 19,000 kernels per acre, i.e., planting of 2 kernels every 18 or 20 inches in rows 40 inches apart. Ear weight consistently decreased with increasing planting rates and silking was delayed by one day for every additional 3600 to 4000 kernels planted per acre. The percentage of lodged plants increased up to a stand of about 20,000 plants per acre and decreased with thicker plantings probably owing to the protection from wind afforded by the very heavy stand.
Hunt (33) tried six different degrees of thickness of planting viz 47520, 23760, 15840, 11880, 9504 and 5940 kernels per acre and noticed a nearly constant increase in the weight of individual stalks and ears from the thickest to the thinnest planting. The total yield of corn was, however, greatest in the thickest planting and it gradually decreased as the stand grew thinner.

Latta (43) and (45), Latta and Ives (46), Latta and Anderson (47) and (48) tried plant to plant spacings varying from 6 inches to 23 inches within rows and reported that the greatest yields of ears and stalks were obtained when the plants stood 12 inches to 14 inches apart in the rows and that thick plantings invariably reduced the size of ears and the percentage of grains.

Newman & Clayton (64) got increased yields from two stalks to the hill over one stalk per hill at two feet apart upon soil deeply and thoroughly prepared, heavily fertilized and judiciously cultivated. At the Illinois Agricultural Experimental Station (3), larger corn yields were obtained with thick plant populations during 1933. Rows were 3 feet and three inches apart and a stand of 12,000 to 13,000 plants per acre was considered optimum for larger yields. Thicker plantings, however, produced smaller ears and the ratio of ears to stalks increased as the thickness in stand decreased.

Osborn (66) tried several plant populations varying from 2,722 to 16,336 plants per acre and obtained increased grain yields with thick plantings under favourable
soil and moisture conditions. On poor soils the yield tended to decrease with increase in plant population. The number of barren stalks increased under thicker sowings and poor soils as compared to thin plantings and rich soils. The ears and grains were better developed under lower rates of planting than under higher rates. Results of identical nature were reported by Fore (25), Hinkle (28), Kerle (36), Muhr and Rest (62), Seem & Huber (73), and Van (81).

Hume et al (32) and Williams (85) got increased corn yields by growing one grain every 12 inches or two grains every 24 inches in rows 42 inches apart over planting 3 grains every 36 inches or 4 grains every 48 inches.

Leonard & Robertson (49), Roberts and Kinney (69) and Williams & Welton (86) observed in a comparison of different rates of planting that the total yield of corn from 4 or 5 plants per hill was higher than from 3, 2 or 1 plant per hill in rows 42 inches apart. They recommended relatively thick planting on rich soils and thin planting on poor soils. For average corn lands, they favoured a stand of 3 stalks per hill.

Richey (68) preferred thin sowings over thick sowings as the farmer produced larger ears, had few barren plants, and reduced the tendency to lodge.

Stringfield and Thatcher (78) found that increasing the stand from thin to thick increased barrenness and stalk breakages. The same authors (79) compared 30, 40, 50, 60, 70 & 80 inches row spacings with an acre rate of 15,680 seeds and observed that where the soil and season would produce less than 30 bushels of grain per acre, the yield
dropped gradually as row spacing was raised above 30 inches. But with a soil and season that would produce 70 to 100 bushels of grain per acre, there was no perceptable loss by widening the row spaces to 50 inches— a loss of only 4 bushels at the 60 inch row space and a loss of about 9 bushels at the 70 inch row space.

Wallace and Bressman (82) tried 1, 2, 3, 4 and 5 plants per hill and recommended the planting of 4 kernels per hill on rich soil with favourable season and 3-3 kernels on soils of average or below-average fertility. Grain and stalk yield increased with thicker plantings but the weight of ears and the number of two eared plants decreased, while the number of barren plants increased under closer spacings. Crowther et al (19) did not notice any increase in leaf number under any spacing, but the spacings closer than the optimum increased the proportion of completely sterile plants.

Watson & Davis (83) got the highest yield of shelled corn with the closest spacing of 2.79 square feet of soil area per plant whereas the best yield of marketable ears was obtained with the wider plant spacing of 3.41 square feet space.

While the work done in the foreign countries is fairly exhaustive, very little work has been done in India on the spacing of maize. From practical experience, the Punjab farmer has formed his own impressions about the spacing of crops which are expressed in the popular couplet: "Dai taposi kangni, dango dang kapah, lef di bukal mar ke chhalian vich di lan' ja", which means that maize crop should
be spaced so widely that a man with a quilt wrapped round him can easily walk through the rows. This popular belief, however, has not been experimentally tested. Some spacing experiments were conducted at the Imperial Agricultural Research Institute, Pusa (4), during the years 1932 to 1935. The spacings tried were 9, 12, 15, 18 and 24 inches between the plants in rows 2.5 feet apart. The closest spacing of 9 inches gave the highest outturn of both grain and fodder. Sharma (75) tried three row spacings viz., 2 feet, 2.5 feet and 3 feet at the Indian Agricultural Research Institute, New Delhi. There was no significant difference in plant height or in grain and stalk yields per acre under the three row spacings. The ear development was recorded to be slightly better in wider row spacings than in the closer.

**Correlation Studies.**

Hutcheson & Wolfe (34) found that the yield of corn was significantly and positively correlated with ear length, circumference and the size of the grain. The relation between the yield and the percentage of grains and the number of rows of grain was noticed to be small. Hughes & Robinson (31) noticed that definite relationship was found between the yield and the length of the ear, weight of the ear, number of kernel rows and weight of kernels. When all the ears were considered, the longer and heavier ears were found to give larger yields. Ear circumference, on the other hand, showed a slight relationship with grain yield. Love & Wentz (50) found cob circumference to be significantly correlated with yield, while cob length, weight of kernels and number of grain rows showed positive but small relationship with grain yield.
Montgomery (58) observed that a stout heavy stalk had a larger leaf area and also a bigger ear up to a certain limit. Muhr & Post (62) suggested that there was a definite relationship between the average ear size and yield; the larger the ear, the larger the yield.

Residual effect of Treatments.

Brandon (12) studied the residual effect of 44 inch and 88 inch row spacings under maize on the succeeding wheat crop and found that the double spaced rows yielded 2 bushels per acre higher yield than the single spaced rows of 44 inches. Crowther et al (19) reported that the residues of 200 Kgs nitrogen fertilizer applied to the wheat crop gave an increase of 0.5 ardebs of maize. The effects of wheat spacings were significant, the closely spaced wheat reducing the maize yield by 0.5 ardebs as compared with the widely spaced wheat. Dumenil (20) noticed that when 40 to 60 lbs. of nitrogen was applied to corn, part of it was carried over and increased the yield of oats following the corn crop. The residual effect from 60 lbs. of nitrogen increased the oats yield from 3 to 16 bushels per acre. Similar results were obtained by Luthra (51) and Sharma (75).

Sowing time.

Latta (43) and Latta & Anderson (47) obtained the best results with early planted corn. Robertson et al (70) obtained higher yields from early planting. Late planted corn fell off rapidly in bushel weight and grain yield. Williams and Walton (86) found that extremely early or extremely late sowings gave poor yields of corn as compared with normal sowing dates. The amount of barrenness for the latest planting
was 2.7 times greater than the earliest sowing. Results of similar nature were reported by Frese (26), Kiesselbach et al (39), McClelland (53) and Mitchell (57).

Thus the factors of spacing, manuring, and date of sowing have been found by several workers to exercise considerable influence on the growth and yield of the maize plant.