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Growth and yield of watermelon affected by chemical fertilizers

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Abstract
The present investigation was carried out at Fruit Research Station, Department of Horticulture, Junagadh Agricultural University, Junagadh on growth and yield of watermelon affected by chemical fertilizers during the year 2010. The experiment was laid out in Randomized Block Design with Factorial concept (FRBD). In all there were 16 treatment combinations, which were assigned at random in each plots within replications such as a chemical fertilizers treatments in which four levels of Nitrogen (N_1: 50, N_2: 75, N_3: 100 and N_4: 125 kg/ha), two levels of Phosphorus (P_1: 75 and P_2: 100 kg/ha) and two Levels of Potassium (K_1: 40 and K_2: 60 kg/ha). The results of experiment reveal that growth characters such as number of branches per plant, number of nodes per plant and length of main axis were significantly influenced by higher dose of nitrogen (125 kg/ha). Number of branches and nodes per plant were also found significantly different due to levels of phosphorus and significant differences were observed in number of branches per plant and length of main axis due to different levels of potash. The yield attributing characters such as fruit length, number of fruits per plants and average fruit weight were significantly increased with increasing levels of nitrogen (0 to 125 kg/ha). Similarly yield attributing characters increased with increasing levels of potash (0 to 60 kg/ha). The average fruit weight was increased significantly with higher dose of phosphorus. Yield of fruit per plant and per hectare were registered maximum under higher dose of nitrogen (125 kg/ha) and potash (60 kg/ha).

Keywords: Watermelon, chemical fertilizers, growth and yield

Introduction

Cucurbits is a popular group of vegetable in many parts of the world, occupy a large area under cultivation in India. Cucumbers, melons, pumpkins, squashes, and gourds belong to the cucurbitaceae family. Among the cucurbits, watermelon (*Citrullus lanatus* Thunb.*)* is one of the important vegetable crops grown extensively in India and in tropical and sub-tropical countries of Europe and Africa. It is a major river-bed crop of Uttar Pradesh, Rajasthan, Gujarat, Maharashtra and Andhra Pradesh. Its growth is favoured by long period of warm, dry weather. A temperature ranging from 25 ^{0}C to 30 ^{0}C is ideal for growth and 25 ^{0}C is the best temperature for fruit setting of watermelon. Environment significantly influences the flavour and sweetness of watermelon. It has been of high nutritive value and it is widely grown in India as well as in whole world and consumed as vegetable. It is also consumed as a juice due to its good taste and flavouring characteristics. Watermelon is rich in vitamin 'B_6' and 'C' as well as low in sugar and calories because of high percentage of water in the fruits, which are useful for those who want to, reduce body weight**.** It also contains high potassium and low sodium. The antioxidants in watermelons help reduce the risk of heart attack [2].

In order to obtain high yield of water melon, there is need to augment the nutrient status of the soil to meet the crop's need and thereby maintaining the fertility of the soil. One of the ways of increasing the nutrient status is by boosting the soil nutrient content either with the use of use of inorganic fertilizers or organic materials [3]. Watermelon is a heavy feeder of nitrogen and therefore required a liberal application of 200 kg. NPK compound fertilizer to be applied before sowing, followed by application of nitrogenous fertilizers at 5 weeks at intervals up to flowering stage [13, 14]. Inorganic fertilizers are the most important sources of N. Adequate supply of N is associated with high photosynthetic activity, vigorous vegetative growth and a dark green colour of the leaves [6]. Extensive use of inorganic fertilizer has a depressing effect on yield. This causes reduction in number of fruits, delays and reduces fruit setting, which subsequently delay ripening and leads to heavy vegetative growth [1, 6].

Nutrients play very important role in growth and development of watermelon. Nutrient is also one of the main factors which govern the yield and quality of fruit of watermelon. Among them, N is the first limiting factor required to promote growth and to increase the size of the fruit. Nitrogen application markedly influence the vegetative growth, bearing habit, yield and quality of fruits and also helpful for the production of female flowers. Phosphorus has vital role in yield attributes and qualitative parameters. An application of 120 kg N/ha in watermelon cv. 'Arka Manik' significantly increased the fruit yield compared with that at 60 kg N/ha, but at 180 kg N/ha it had no significant effect [5]. The increase in yield with increase in N application was mainly due to significant increase in fruit size but, had no significant effect on total soluble solids (T.S.S) and nitrate nitrogen content in juice [5]. The nitrogen applied at 120 kg N/ha significantly increased fruit yield, weight and T.S.S as compared to control and 60 kg N/ha [7]. An application of 80 kg P_2O_5/ha recorded significantly higher number of fruits per vine and 50 kg P_2O_5/ha gave higher fruit yield as compared to control in cucumber during *Kharif* season [12]. An application of K (50 kg/ha) produced watermelon fruits with a greater weight. The present investigation was undertaken to evaluate the potentiality of Nitrogen, Phosphorus and Potassium on influencing the growth and increasing flowering in order to yield of watermelon particularly with regard to environmental condition.

Materials and methods

The present investigation was carried out at Fruit Research Station, Department of Horticulture, Junagadh Agricultural University, Junagadh on growth and yield of watermelon ***as*** affected by chemical fertilizers. The work was carried out during the year 2010 (21.50ºN latitude, 70.50ºE longitude with an altitude of 60 meters above the mean sea level). The experiment was laid out in Randomized Block Design with Factorial Concept. In all there were 16 treatment combinations, which were assigned at random in each plot within replications such as a chemical fertilizers treatments in which four levels of Nitrogen (N_1: 50, N_2: 75, N_3: 100 and N_4: 125 kg/ha), two levels of Phosphorus (P_1: 75 and P_2: 100 kg/ha) and two Levels of Potassium (K_1: 40 and K_2: 60 kg/ha). The physical and chemical properties of soil, two composite soil samples were taken randomly, each from 0-15 depth of soil before and after sowing of crop. The values available nitrogen, phosphorus and potash obtained 41.90 kg/ha, 33.50 kg/ha and 139.90 kg/ha along with organic carbon 0.68 percent, pH 7.6 and electric conductivity 0.52 dS per meter in experimental soil, respectively. The experimental material comprised of genetically pure seeds of watermelon cv. Kiran. Nitrogen was applied in the form of urea (46 % N_2) in two splits doses, half dose of nitrogen was uniformly applied as basal dose at the time of sowing and remaining half quantity of the nitrogen was applied after one month of sowing. The phosphorus was applied in the form of Single Super Phosphate (16% P_20_5) as a basal dose in the furrow before sowing as per treatment allocation. The potassium was applied in the form of Murate of Potash (60% K_2O) as a basal dose in furrows before sowing and all other cultural practices are done as per recommendation. The data of all characters were studied subjected to statistical analysis of variance technique [10]. The method of analysis of variance for randomized block design was used. The treatment differences were tested by "F" test of significance on the basis of null hypothesis. The appropriate standard error of mean (S.Em.) was calculated in each case and the critical difference (C.D.) at five per cent level of probability was worked out to compare the two treatments means where the treatment effects were significant.

Results and discussion

Effect of nitrogen

The data (Table 1) indicated that the effect of different levels of nitrogen was found significant for number of branches per plant of watermelon. Number of branches increased with increase in level of nitrogen. Significantly maximum number of branches (13.46) was obtained in N_4, which was found to be significant with N_3 with the value of 13.13, however, among different levels of nitrogen the minimum number of branches 12.00 was found in N_1. The present finding was supported by [9, 16] in watermelon and [15] in muskmelon. They reported that the increase in number of branches per plant might be due to fact that nitrogen application increased more metabolites transported for growth. These beneficial effect of nitrogen on promoting growth due to enhanced synthesis and accumulation of proteins, amino acids and enzymes, which are responsible for cell division and cell elongation hence growth of the plant was increased.

The effect of different levels of nitrogen was found to be significant on number of nodes per plant of watermelon. Significantly the maximum number of nodes per plant 52.98 was recorded at N_4, which was at par with N_3 level, whereas, the minimum number of nods per plant 46.98 was found in N_1 level and it was at par with N_2.

The data indicated that the differences observed in length of main axis due to levels of nitrogen were significant. Length of main axis was found to increase with increasing level of nitrogen. Significantly highest length of main axis 214.91 cm was recorded at N_4 followed by N_3 and N_2, however, the shortest length of main axis 171.50 cm was observed in N_1. Similar findings was also been obtained by [9, 16] in watermelon and [15] in muskmelon. They reported that the maximum length of main axis was recorded due to enhanced synthesis and accumulation of proteins, amino acids and enzymes, which are responsible for cell division and cell elongation hence growth of the plant was increased.

The number of fruits per plant increased with increasing levels of nitrogen. Significantly the maximum number of fruits per plant was 3.17 recorded with N_4. These studies are in accordance with that of [5]. They reported that the maximum number of fruits per plant (3.17) was obtained at N_4 caused by drawing of photosynthate to the flower as a consequence of intensification of sink.

The data (Table 1) indicated that the effect of different levels of nitrogen was found significant for average fruit weight of watermelon. Significantly maximum average fruit weight (3446.85 g) was obtained in N_4 followed by N_3. The present results are in agreement that of [5, 7] and [11] in muskmelon. They are reported that the maximum average fruit weight (3446.85 g) was obtained at N_4 due to the improved vegetative growth of plants under the highest level of nitrogen, which resulted in more storage and subsequent utilization of carbohydrates and thus improved fruit weight. The data in Table 1exposed that an application of different levels of nitrogen was found to be significant. N_4 produced significantly maximum fruit yield per hectare 374.33 qt followed by N_3.

Effect of phosphorus

The data presented in Table 1 revealed that the number of branches per plant was significantly affected by different

levels of phosphorus. The higher number of branches per plant (13.15) was recorded in P_1 level of phosphorus followed by P_2 level of phosphorus with the value of 12.27. These results are in accordance with that of [16] in watermelon and [8] in long melon. They reported that the higher number of branches per vine was obtained at P_2 due to the fact that adequate supply of phosphorus resulted in better growth of the crop. Phosphorus is a structural element of certain co-enzyme, which is involved in energy transfer thus, improves photosynthetic process and increased the growth of the crop.

The data indicated that an application of phosphorus was found significant on number of nods per plant. The higher number of nods per plant 51.68 was obtained in P_1, whereas the lower number of nods per plant 49.18 was noted in P_2. The above results were in consonance with those of [16] in watermelon and [8] in long melon. They reported that the higher number of nods per plant was obtained by phosphorus due to adequate supply of phosphorus resulting in better growth of the crop. As phosphorus is a constituent of cell nodes and for development of metabolism. Further, the data showed that the different levels of phosphorus did not significantly influence in length of main axis and number of fruits per plant of watermelon.

The data presented in Table 1 revealed that the average fruit weight was significantly affected by different levels of phosphorus. The highest average fruit weight (3207.04 g) was recorded in P_2 level of phosphorus followed by P_1. The current investigation was supported by the results [4, 16] in watermelon, [8] in long melon and [17] in cucumber. They observed that the maximum average weight of fruit (3207.04 g) was obtained at P_2. It is obvious that phosphorus influenced photosynthesis, biosynthesis of protein and phospholipids, nucleic acid synthesis, membrane transport and cytoplasmic streaming. It was also observed that the effect of different levels of phosphorus did not show significantly influence on the fruit yield per hectare of watermelon.

Effect of potash

The different levels of potash had significant affects on number of branches per plant of watermelon. However, the highest number of branches per plant 13.25 was recorded with K_2 level of potash. While, significantly less number of branches per plant (12.17) was recorded in K_1 level of potash. Similar finding have also been obtained by [4, 16] in watermelon and [15, 11] in muskmelon. They studied that the increasing application of potash recorded significant increase in number of branches per plant. The positive effect of potash on growth characters is known to augment cell division and cell expansion resulting in increased growth. It was also observed that different levels of potash application was found non-significant on number of nods per plant of watermelon.

The differences observed due to levels of potassium in length of main axis was found significant. However, more length of main axis 198.03 cm was observed at K_2 level of potash, while significantly lower length of main axis 184.76 cm was recorded in K_1. The data also indicated that the effect of different potassium levels was found to be significant in respect of number of fruit per plant. However, maximum number of fruits per plant 2.94 was recorded with K_2. While minimum number of fruits per plant 2.72 was recorded by K_1.

Table 1: Effect of chemical fertilizers on growth and yield attribute parameters of watermelon, cv. 'Kiran'.

Treatments	No. of branches per plant	No. of nods per plant	Length of main axis (cm)	No. of fruit per plant	Average fruit wt. (g)	Fruit yield/ha (qt)
Nitrogren (kg/ha)						
N_1= 50	12.00	46.98	171.50	2.30	2904.08	301.15
N_2= 75	12.25	49.86	182.12	2.78	3023.24	350.22
N_3=100	13.13	51.90	197.04	3.08	3172.70	355.05
N_4= 125	13.46	52.98	214.91	3.17	3446.85	374.33
S.Em. ±	0.39	1.05	4.89	0.06	63.95	7.40
C.D. at 5%	1.13	3.04	14.09	0.16	184.30	21.33
Phosphorus (kg/ha)						
P_1=75	13.15	51.68	194.31	2.84	3066.39	345.14
P_2= 100	12.27	49.18	188.48	2.82	3207.04	345.23
S.Em. ±	0.28	0.75	3.46	0.04	45.22	5.23
C.D. at 5%	0.80	2.15	NS	NS	130.32	NS
Potassium (kg/ha)						
K_1=40	12.17	49.49	184.76	2.72	3069.38	337.07
K_2=60	13.25	51.38	198.03	2.94	3204.05	353.31
S.Em. ±	0.28	0.75	3.46	0.04	45.22	5.23
C.D. at 5%	0.80	NS	9.96	0.11	130.32	15.08
Significant Interaction						
N x P	NS	NS	NS	NS	NS	NS
N x K	NS	NS	NS	Sig.	NS	Sig.
P x K	NS	NS	NS	NS	NS	NS
N x P x K	NS	NS	NS	NS	NS	NS
C.V. %	10.81	7.28	8.93	6.84	7.11	7.53

The data on average fruit weight as affected by various fertilizer treatments are presented in Table 1. The presented data revealed that the various fertilizer treatments were found significant. The different levels of potash had significant effect on average fruit weight of watermelon. However, the maximum average fruit weight 3204.05 g was recorded with K_2. While, significantly minimum average fruit weight 3069.38 g were recorded in K_1. The present studies are in accordance with that of [7] in watermelon and [11] in muskmelon. They reported that the maximum average fruit weight (3204.05 g) was recorded at K_2. It is oblivious that potash fertilization increased nutrient supply in rhizosphere which culminated into more absorption of nutrients by the crop.

The data on fruit yield per hectare as influenced by various fertilizer treatments are presented in Table 1. The data

indicated that the effect of different potassium levels was found to be significant. However, increasing level of potassium with increased in fruit yield per hectare of watermelon was observed. Maximum fruit yield per hectare 353.31 qt was recorded with K_2 level of potassium. While, the minimum yield per hectare was recorded in K_1 level.

Effect of interaction

The interaction effect of nitrogen and potassium (N x K) with respect to mean number of fruits per plant and fruit yield per hectare was found to be significant, while remaining interactions were found to be non-significant. However, the interaction effect of nitrogen, phosphorus and potassium did not show any significant influence with respect to growth and yield attributing characters of watermelon.

Conclusion

From the above results it could be concluded that for profitable cultivation of watermelon, fertilizer application at the rate of 125 kg nitrogen per hectare, 75 kg phosphorus and 60 kg potassium per hectare has been found optimum growth and maximum yield of watermelon.

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