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Influence of Phosphorus and Potassium on Growth and Yield of Cauliflower

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ABSTRACT

Two winter seasons experiment was conducted in 2013 - 2014 and 2014 - 2015 at Vegetable Research Farm, Fac. of Agric., Mansoura Univ. to investigate phosphorus and potassium impact on growth and yield of cauliflower. The lay out of the experiments were factorial in the complete randomize block design with three replicates. The main plots were phosphorus (i.e.; 45, 60, 75 and 90 kg as P_2O_5 /fed.). The sub – plots were potassium (i.e. 30, 45 and 60 kg as K_2O /fed.). The data cleared that vegetative growth characters (i.e.; plant height, leaf area, weight of fresh leaves and leaves dry matter %), leaves chemical component (i.e., chlorophyll a, chlorophyll b, carotenoids, N, P and K). Curds yield and its physical quality attributes (i.e.; weight, diameter, compactness index, dry matter % and non- burst), curds chemical quality attributes (i.e.; Vitamin C, TSS, N, P and K) were significantly influenced by the interaction between phosphorus and potassium levels in both seasons. On contrast, leaves number were not affected by the combination of phosphorus and potassium.The interaction between phosphorus at 75 kg P_2O_5 and potassium at 45 kg K_2O /fed. was the most effective combination, Since it achieved the highest leaf area, leaves fresh weight, chlorophyll a, chlorophyll b, carotenoids, curd weight, curd diameter, curd compactness index, curd dry matter %, curds yield /fed., Vitamin C, TSS and N % of curd in both seasons. On the contrary, phosphorus at 45 kg P_2O_5 and potassium at 30 kg K_2O gave the lowest values of curd yield and quality parameters. Hence phosphorus at 75 kg P_2O_5 and potassium at 45 kg K_2O /fed.. is recommended to attain optimum curd yield and its component of cauliflower in the study area and other similar condition.

INTRODUCTION

Cauliflower (*Brassica oleracea,* L var. botrytis) is important crop belonging to the family Brassicaceae. It is considered a common vegetable crop in Egypt because its appropriate method of production technology and nutritive value. Cauliflower contains high concentrations of vitamin C, A, thiamine, riboflavin, niacin, carotenoid, which are protect people from cancer. (Joao, 2012)

The major factors, which contribute to the crop yield include; use of improved cultivars, balanced nutrition and cultural practices.

Application of balanced fertilizer increases vegetative growth and improves yield and quality of the product. Optimum fertilizers application for cauliflower in calcareous soils are important for obtaining high yield with high quality of curd. Many studies have shown that levels of available potassium, phosphorus and micronutrients are fairly low under calcareous soils conditions (FAO, 2005). The primary macro nutrients e.g. phosphorus and potassium are important for plant growth, maturity, curd yield and quality.

Phosphorus plays an indispensable role within the energy storage and transfer in the form of adenosine diphosphate ADP, adenosine triphosphate ATP, as well as deoxyribonucleic acid (DNA), an essential part of ribonucleic acid (RNA). It also enhance root development and enlargement affect cell wall division, seed germination, flowering, fruiting, synthesis of fat, starch and in fact most biochemical activities like amino acid synthesis. Application of phosphorus is also important in increasing the efficacy of other nutrients (Arif *et al*., 2005)

The importance of potassium fertilization in Egyptian agriculture has risen since the completion of the High Dam which resulted in the deposition of the suspended Nile silt in the upstream of the formed lake. The Nile silt enriched the Egyptian soils with potassium during the seasonal floods. However, continuous cropping without replenishing nutrients can cause an irreparable damage to soil fertility. (Abd El-Hadi *et al*., 1997).

Clay soils contain relatively higher amounts of total potassium as a component of hardly soluble minerals, however only a small fraction is present in available form potassium levels in Egyptian soils are going to be depleted due to intensive cropping and cultivation of high yielding crop varieties. Moreover, soils that are marginal to deficient in available potassium, negative effects on crops yield and qualities could be occurred.(Shaaban and Abou El-Nour, 2012).

Potassium deficiency may affect respiration, photosynthesis, chlorophyll development, and water content of leaves (Sangakkara *et al*., 2000).

The scientific researches indicated that optimum dose of phosphorus and potassium increase curd yield and its component of cauliflower (Filho *et al.,* 2015; Sharma 2016).

The current work is an attempt to evaluate the impact of phosphorus and potassium rates on yield and its component of cauliflower.

MATERIALS AND METHODS

Two winter seasons experiment was conducted in 2013 - 2014 and 2014 - 2015 at Vegetable Research Farm, Fac. of Agric., Mansoura Univ. to investigate phosphorus and potassium impact on growth and yield of cauliflower. The lay out of the experiments were factorial in the complete randomize block design with three replicates. The main plots were phosphorus (i.e.; 45, 60, 75 and 90 kg as P_2O_5 /fed.). The sub – plots were potassium (i.e. 30, 45 and 60 kg as K_2O /fed.)

Soil samples were taken at random from the different sites from the top layer (0-30 cm depth) for physical and chemical analysis. physical and chemical properties of experimental Soil are presented in Table 1.

Table 1. Physical and chemical properties of the experimental soil during 2013-2014 and 2014-2015 seasons

Soil characters	silt	Clay	sand	Texture	PH	EC dsm^{-1}	OM %	$CaCO_3$	N mg/ kg	P mg/kg	K Mg /kg
1st seasons	40.6	37.2	22.2	Loamy	8.22	1.58	1.8	3.39	52.9	5.7	2.8
2ed seasons	41.2	36.8	22.0	Loamy	8.11	1.77	2.o	3.45	54.2	6.1	2.9

Phosphorus was added during preparation of the soil as calcium super phosphate (12.5 % P_2O_5). Potassium was applied in two splits as potassium sulphate (48% K_2O) i.e. half at transplanting and the remaining half after 30 days of transplanting. Nitrogen at 70 kg /fed. was applied as ammonium nitrate (33.5 %) in two splits at 30 and 60 days after transplanting. Cauliflower transplants (cv. Fargo 45 days old) were transplanted on 1st and 3rd of November in the 1st and 2ed seasons respectively. Seedlings were transplanted on one side of each ridge in 70 cm width and 50 cm apart. Each plot consists of five ridges, each one is 3.0 m long, plot area was 10.5 m^2.

Experimental design:

A split plots experiment in a complete randomized blocks design with three replicates was conducted. Phosphorus levels were assigned in the main plots, whereas the potassium rates were randomly located in the sub plots.

Measurements:

After 105 days from transplanting, five plants were taken randomly from each plot and data were recorded in both seasons as follows.

Vegetative growth characters:

Plant height, leaves No, leaf area, leaves fresh weight and leaves dry matter %.

Leaves chemical component:

N, P, K, chlorophyll a, chlorophyll b and carotenoids were determined in leaves according to AOAC (1990).

Curds yield and its physical attributes:

Curd (weight, diameter, compactness index and dry matter %), curds yield (ton /fed.) and curd non - burst % at 115 (DAP) day after planting.

Curds chemical quality:

Vitamin C, TSS, N, P and K were measured according to AOAC (1990).

Statistical analysis:

All the obtained data were subjected to standard analysis of variance procedure. The values of LSD were calculated at 5% according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Vegetative growth characters:

The response of cauliflower vegetative growth parameters (i.e.; Plant height, leaves number, leaf area, leaves fresh weight and leaves dry matter %) were significantly affected by the phosphorus and potassium levels, except the leaves number /plant (Table 2). The maximum plant height vales were recorded at 75 kg P_2O_5 with 30 or 45 kg K_2O /fed., whereas the minimum values were achieved by using 45 kg of P_2O_5 and K_2O at 30 kg /fed. in the two studied seasons.

The highest leaf area and leaves fresh weight values were recorded by application phosphorus at 75 kg P_2O_5 and potassium at 45 kg K_2O /fed. On contrast, the lowest values were obtained by 45 kg P_2O_5 and K_2O at 30 kg / fed. in the two seasons of the study.

AS for leaves dry matter %, the highest values were recorded by using phosphorus at 75 kg P_2O_5 and potassium at 60 kg K_2O /fed., whereas the lowest values were recorded at 45 and 30 kg of P_2O_5 and K_2O /fed., respectively in both seasons.

In this study, high level of phosphorus (75 kg P_2O_5) in combination with potassium at (30, 45 or 60 kg K_2O) marked better the vegetative growth of cauliflower due to Phosphorus element is one of the main nutrients for most plant. It is an essential constituent of many organic compounds that are very important for metabolic processes and root development, an essential component of the energy currency of the living cell: Adenosine Triphosphate (ATP) as well as deoxyribonucleic acid (DNA), an essential part of ribonucleic acid (RNA) which is responsible for directing protein synthesis in both plants. Moreover, phospholipids which play critical roles in cellular membranes are another class of universally important phosphorus- containing compounds. Furthermore, adequate phosphorus nutrition enhances many aspects of plant physiology like fundamental process of photosynthesis and respiration. (Arif *et al.,* 2005).

Also, potassium is an essential nutrient for plant growth and plays an important role in many metabolic processes such as photosynthesis, use of water and synthesis of amino acid and protein as well as translocation of sugars and assimilates within the plant and the accumulation of high molecular carbohydrates which necessary for fruit formation and development which leads to increase plant growth (Yildirim *et al.,* 2009)

On the other hand, The highest rates of phosphorus and potassium more optimum dose do not make better growth characters and this may be over nutrients using convert to a negative impacts on plant growth, plant toxicity, leaf chlorosis, and micronutrient deficiency (Hawkin *et al.*, 2008).

These findings are in line with Mahmud *et al*. (2007), Islam *et al.* (2010), Hassan *et al*. (2013), Zaki *et al.* (2015) and Neethu *et al*. (2015) on broccoli; Filho et *al.* (2015), Elahi *et al*. (2015) and Sharma (2016) on cauliflower; Prasad *et al*. (2009) chinese cabbage.

Table 2. Influence of phosphorus and potassium fertilization on vegetative growth characters of cauliflower in 2013-2014 and 2014-2015 seasons.

Treatments		Plant height (cm).		leaves No./ plant		leaf area (cm^2) /plant		Leaves F.W. g/plant		Leaves dry matter %.	
P_2O_5 kg/fed.	K_2O kg/fed.	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
45	30	51.9	51.6	20.6	20.0	8084	7925	1347	1357	10.34	9.97
	45	59.3	59.0	22.3	22.0	14676	13977	1567	1493	12.13	11.55
	60	56.9	56.6	21.3	21.0	10438	10037	1534	1475	11.91	11.45
60	30	59.1	58.6	19.0	18.6	9788	9596	1384	1321	10.41	10.21
	45	59.4	59.0	21.3	21.0	18167	17302	2007	1911	14.03	13.36
	60	59.4	59.3	21.3	20.6	11987	11525	1631	1568	11.99	11.53
75	30	62.9	62.3	20.6	19.6	9925	9731	1690	1657	10.91	10.69
	45	62.6	62.0	21.6	21.3	19852	18906	2103	2003	11.30	10.86
	60	57.2	56.6	20.3	20.0	15008	14430	1731	1665	14.74	14.04
90	30	57.9	57.3	21.3	20.3	9269	9087	1515	1486	10.57	10.37
	45	60.2	59.6	22.3	22.0	13518	12875	1629	1551	11.34	10.80
	60	59.9	59.3	21.6	21.0	10945	10524	1553	1494	10.48	10.08
LSD 5%		6.7	7.4	NS	NS	5670	5455	616	466	1.68	1.72

Leaves chemical component:

The obtained results revealed that there were significant differences in N, P, K, chlorophyll a, chlorophyll b and carotenoids in cauliflower leaves with different combination of phosphorus and potassium levels in the two seasons of study (Table 3). The highest values of N % was recorded by phosphorus at 60 kg P_2O_5 and potassium at 45 kg K_2O /fed. On other hand the maximum P percentage in leaves tissue was noticed with combination of 75 kg P_2O_5 and at 45 kg K_2O /fed. in the both seasons. Also, the highest values of K % in leaves was obtained by 75 kg P_2O_5 and 30 kg K_2O /fed. On contrast phosphorus at 45 kg P_2O_5 and potassium at 30 kg K_2O /fed was gave the lowest values of N, P and K % in the two seasons. Similar results were obtained by Hassan *et al*. (2013) and Zaki *et al.* (2015) on broccoli.

Concerning cauliflower leaves pigments, the results presented in Table 3 shows that the maximum concentrations of chlorophyll a, chlorophyll b and carotenoids were recorded by application of phosphorus at 75 kg P_2O_5 and potassium at 45 kg K_2O. On contrast the minimum values were recorded with phosphorus at 60 kg P_2O_5 and potassium at 45 kg K_2O /fed.

Table 3. Influence of phosphorus and potassium fertilization on leaves chemical content of cauliflower in 2013-2014 and 2014-2015 seasons.

Treatments		N (%)		P (%)		K (%)		Chl. a mg/100 F.W		Chl.b mg/100 F.W		Carotenoids mg/100g F.W	
P_2O_5 kg/fed.	K_2O kg/fed.	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
45	30	1.54	1.51	0.222	0.219	2.95	2.99	46.2	45.3	22.9	22.5	13.8	13.6
	45	2.23	2.13	0.255	0.250	3.12	3.16	47.5	45.2	23.5	22.4	14.2	13.9
	60	2.63	2.59	0.304	0.329	3.22	3.26	44.8	43.1	22.3	21.6	13.6	13.1
60	30	1.61	1.58	0.334	0.346	3.02	3.06	46.4	45.5	22.8	22.4	14.1	13.9
	45	2.94	2.91	0.343	0.343	3.06	3.10	42.8	40.8	21.9	21.1	13.8	13.3
	60	2.66	2.62	0.361	0.344	3.46	3.50	43.0	41.3	22.6	21.5	13.6	13.0
75	30	2.17	2.12	0.357	0.346	4.07	4.13	46.0	45.1	22.1	21.6	12.6	12.4
	45	2.80	2.77	0.402	0.394	3.51	3.56	54.4	51.8	26.7	25.4	15.8	15.1
	60	2.80	2.76	0.383	0.377	3.00	3.04	47.9	46.1	23.2	22.4	14.2	13.7
90	30	2.66	2.60	0.327	0.323	3.44	3.49	46.3	45.3	22.2	21.9	13.6	13.3
	45	2.75	2.77	0.347	0.34	3.11	3.15	45.5	43.3	22.0	20.7	13.7	13.5
	60	2.38	2.34	0.354	0.349	3.20	3.27	44.9	43.2	22.3	21.4	13.8	13.3
LSD 5%		0.37	0.38	0.014	0.018	0.17	0.20	5.1	4.9	3.4	2.9	2.3	2.2

Curds yield and its physical attributes:

The recorded data in Table 4 indicated that curd (weight, diameter, compactness index and dry matter %) and curds yield of cauliflower are affected significantly by interaction between phosphorus and potassium levels. The maximum values of these characters were achieved by application phosphorus at 75 kg P_2O_5 with potassium at 45 kg K_2O /fed., whereas the least values of curd (weight and diameter) and curds yield were recorded with phosphorus at 45 kg P_2O_5 and potassium at 30 kg K_2O /fed. in both seasons. While the lowest values of curd compactness index and curd dry matter % were recorded with 90 kg P_2O_5 and 30 kg K_2O /fed.

Regarding the non-burst of cauliflower curd (115 DAP) days after planting was significantly affected by interaction between phosphorus and potassium levels. phosphorus at 60 kg P_2O_5 and potassium at 45 kg K_2O /fed. was gave the maximum values, whereas the minimum values were achieved by using 45 kg of P_2O_5 and K_2O at 45 kg /fed. (Table 4) in both seasons.

The obtained increase in curds yield and its physical quality with high level of phosphorus 75 kg P_2O_5 /fed. in combination with potassium at 45 kg K_2O /fed. can be attributed to the fact that Phosphorus and potassium in plants improve vegetative growth of cauliflower plant (Table 2) which in turn to maximum leaf area that also increases photosynthetic. Phosphorus is an essential constituent of many organic compounds that are very important for metabolic processes and root development, an essential component of the energy of the living cell: adenosine triphosphate (ATP) as well as deoxyribonucleic acid (DNA), ribonucleic acid (RNA) which is responsible for directing protein synthesis in both plants. Moreover, phospholipids which play critical roles in cellular membranes formation. Furthermore, adequate phosphorus nutrition promotes many aspects of plant physiology like fundamental process of photosynthesis and respiration. (Arif *et al.,* 2005).

Potassium is an essential nutrient for plant growth and plays an important role in many metabolic processes such as use of water, photosynthesis, synthesis of amino acid and protein as well as translocation of sugars and assimilates within the plant and the accumulation of high molecular carbohydrates necessary for fruit formation and development which leads to increase plant growth and yield (Yildirim *et al.,* 2009)

On the other hand, phosphorus and potassium more ideal doses decreased growth characters and this may be due to over nutrients application converts to adverse impacts on plant growth, plant toxicity, leaf chlorosis, and micronutrient deficiency which led to decline on curd yield and its physical quality (Hawkin *et al.*, 2008).

The previous data are in a line with those obtained by Mahmud *et al*. (2007), Islam *et al.* (2010) Hassan *et al*. (2013) Zaki *et al.* (2015) and Neethu *et al* (2015) on broccoli; Dhakal *et al.* (2009), Filho et *al.* (2015), Elahi *et al*. (2015) and Sharma (2016) on cauliflower; Prasad *et al*. (2009) chinese cabbage

Table 4. Influence of phosphorus and potassium fertilization on curds yield and its physical quality of cauliflower in 2013-2014 and 2014-2015 seasons.

Treatments		Curd weight (g)		Curd diameter (cm)		curd compactness index		curd dry matter %		non-burst %		Curds Yield (ton/ fed.)	
P_2O_5 kg/fed.	K_2O kg/fed.	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
45	30	1351	1325	17.0	16.9	79.2	78.1	6.48	6.36	15.5	16.6	16.22	15.90
	45	1954	1861	22.3	22.0	87.5	84.5	7.15	6.81	0.0	0.0	23.45	22.33
	60	1554	1494	18.5	18.3	82.4	80.1	6.68	6.42	11.1	12.2	18.65	17.94
60	30	1748	1714	21.1	21.0	82.3	81.1	6.53	6.40	12.2	14.4	20.98	20.57
	45	2277	2169	24.8	24.5	91.3	88.1	6.89	6.56	80.0	82.2	27.33	26.03
	60	2127	2045	23.5	23.3	90.3	87.5	6.69	6.43	33.3	34.4	25.53	24.54
75	30	1894	1857	22.7	22.6	83.1	81.9	6.94	6.81	14.4	16.6	22.73	22.29
	45	2380	2267	25.2	24.9	94.2	90.8	7.69	7.32	53.3	54.4	28.56	27.20
	60	2025	1947	23.4	23.2	84.1	81.5	7.18	6.91	42.2	43.3	24.30	23.36
90	30	1604	1572	20.6	20.5	77.5	76.3	6.41	6.29	38.9	40.0	19.25	18.87
	45	2085	1986	23.8	23.5	87.3	84.2	6.87	6.54	16.6	17.7	25.02	23.83
	60	2100	2020	23.6	23.4	88.9	86.2	6.59	6.34	36.6	38.9	25.21	24.24
LSD 5%		655	633	5.3	5.3	11.9	11.5	0.45	0.44	4.7	4.5	7.86	7.60

Curd compactness index mean: curd weight / curd diameter

Curds chemical quality parameters:

Results in Table 5 shows that Vitamin C, TSS, N, P and K were affected significantly by using different phosphorus and potassium levels in both growing seasons of study. The maximum values of Vitamin C, TSS, N and P in cauliflower curd were achieved with application phosphorus at 75 kg P_2O_5 and potassium at 45 kg K_2O /fed. in both seasons. On contrast, the minimum values of Vitamin C in cauliflower curd were recorded with phosphorus at 45 kg P_2O_5 and potassium at 60 kg K_2O of /fed**.** Also, the treatment which consists of 90 kg of P_2O_5 and 30 kg K_2O /fed. was gave the lowest TSS values. The minimum values of N was registered with phosphorus at 60 kg P_2O_5 and potassium at 30 kg K_2O /fed. On the other hand, the minimum values of P % were recorded by using 45 kg P_2O_5 and 30 kg K_2O /fed.

Regarding K percentage in cauliflower curd, the results in the two studied seasons in Table 5 clear that the highest values were recorded by combination of phosphorus at 60 kg P_2O_5 and potassium at 60 kg K_2O /fed. On contrast, the lowest values were achieved with P_2O_5 at 45 kg and K_2O at 30 kg /fed.

These results were in accordance with those reported by Hassan *et al*. (2013), Singh *et al.* (2015) and Zaki *et al.* (2015) on broccoli.

Table 5. Influence of phosphorus and potassium fertilization on curds chemical quality characters of cauliflower in 2013-2014 and 2014-2015 seasons.

Treatments		Vitamin C mg/100g F.W		TSS %		N (%)		P (%)		K (%)	
P_2O_5 kg/fed.	K_2O kg/fed.	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
	30	48.5	46.6	4.7	4.4	2.80	2.76	0.210	0.208	4.45	4.51
45	45	51.3	48.9	6.0	5.7	2.24	2.18	0.421	0.412	4.51	4.57
	60	44.2	43.3	5.4	5.1	2.80	2.71	0.293	0.288	4.85	4.92
	30	52.1	51.1	5.0	4.9	2.10	2.07	0.342	0.338	4.87	4.93
60	45	67.6	64.4	6.4	6.1	2.24	2.18	0.410	0.401	4.87	4.93
	60	57.8	55.1	5.2	4.9	2.80	2.71	0.334	0.329	5.01	5.07
	30	62.4	61.1	4.6	4.5	2.52	2.48	0.219	0.217	4.83	4.9
75	45	87.5	83.4	7.0	6.7	3.29	3.05	0.524	0.514	4.64	4.70
	60	69.3	66.0	5.3	5.0	2.59	2.51	0.502	0.494	4.64	4.70
	30	46.4	45.5	4.0	3.9	2.12	2.09	0.300	0.298	4.68	4.74
90	45	59.5	56.6	4.6	4.4	2.89	2.83	0.330	0.324	4.74	4.80
	60	52.0	49.5	4.3	4.1	3.15	3.02	0.342	0.337	4.95	5.02
LSD 5%		11.9	11.5	0.3	0.3	0.40	0.57	0.013	0.012	0.17	.18

CONCLUSIONS

It can be concluded that growth parameters, yield and yield components of cauliflower were responded positively to phosphorus and potassium fertilizers combination. The curds yield was significantly affected by P and K fertilizer levels. The highest curd weight per plant, curd diameter, curd compactness index, curd dry matter percentage and curds yield /fed. were obtained from application of a combined phosphorus at 75 kg as P_2O_5 with potassium at 45 kg as K_2O /fed..

Hence it is recommended to attain optimum curd yield and its component of cauliflower in the study area and other similar condition.

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تأثير التسميد بالفسفور والبوتاسيوم على النمو والمحصول فى القنبيط

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اجريت تجربتان حقليتان متتالتيان فى عامى ٢٠١٣-٢٠١٤ و ٢٠١٤-٢٠١٥ بمحطة بحوث الخضر– كلية الزراعة جامعة المنصورة. لبحث تاثيرالفسفور والبوتاسيوم على النمو والمحصول فى القنبيط . اربعة مستويات من الفسفور (٤٥- ٦٠- ٧٥- ٩٠ وحدة خامس اكسيد الفسفور للفدان) مع ثلاث مستويات من البوتاسيوم (٣٠ – ٤٥ - ٦٠ كجم اول اكسيد البوتاسيوم للفدان) فى تصميم قطاعات كاملة العشوائية منشقة مرة واحدة فى ثلاث مكررات. اظهرت النتائج ان التفاعل بين الفسفور والبوتاسيوم قد اعطى تاثيرا معنويا على صفات النمو الخضرى (ارتفاع النبات – المساحة الورقية للنبات - وزن الاوراق الطازج - النسبة المئوية للمادة الجافة للاوراق). محتوى الاوراق الكيماوى (كلورفيل أ – كلورفيل ب – الكاروتينيدات –النسبة المئوية لكل من النتروجين- الفسفور والبوتاسيوم). والمحصول والجودة للقرص (وزن القرص- قطر القرص - النسبة المئوية للمادة الجافة للقرص ونسبة عدم التفتح). الجودة الكيمائية للقرص (فيتامين س- المواد الصلبة الذائبة الكلية – النسبة المئوية للنتروجين والفسفور والبوتاسيوم). وفى المقابل فإن التأثير غير معنوى لصفة عدد الاوراق للنبات. ولقد حقق التفاعل بين الفسفور عند معدل ٧٥ وحدة فو٢ ا٥ و ٤٥ بو٢ أ كجم للفدان أعلى القيم (المساحة الوقيى للنبات- الوزن الطازج للاوراق- كلوروفيل أ وب والكاروتينويد- محصول الاقراص للفدان – فيتامين س – المواد اصلبة الذائبة الكلية والنسبة المئوية للنتروجين فى للقرص) بينما اعطى الفسفور عند معدل ٤٥ وحدة فو٢ ا٥و ٣٠ بو٢ أ كجم للفدان اقل القيم لمحصول الاقراص وجودتها. لذلك نوصى بالمعدل ٧٥ وحدة فو٢ ا٥و ٤٥ بو٢ أ كجم للفدان للحصول على اعلى محصول للاقراص وجودتها.