THE INFLUENCE OF NAPHTHALENE-3-ACETIC ACID (NAA) ON GROWTH AND YIELD OF FURROW CULTIVATED LOCAL BLACK RADISH CULTIVAR

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SUMMARY

Sthen plants were sprayed twice after thinning within 2 weeks intervals by naphthalene-3-acetic acid (NAA) at rates of either 0, 20, 30 or 40 $mg.l^{-1}$, to improve growth, yield and yield quality of radishes irrigated whenever 25% of soil available water capacity (AWC) is depleted to a depth of 25 cm. The results showed that radishes required 146.25 mm supplementary irrigation besides 254.3 mm rainfall incidences during the growing season. Results manifested that gradual increases in sprayed NAA rates were substantially concomitant to corresponding gradual increases in radish yield. Thus the highest yield (26.64 $kg.m^{-2}$) was confined to 40 $mg.l^{-1}$ NAA rate. Regression analysis revealed that radish yield is linearly correlated to NAA rates and it could be estimated from the following equation: (yield ($gk.m^{-2}$) = 18.5708 + 0.21442(NAA rate)). No sign of root pithiness was detected in all treatments. No sign of root pithiness disorder was found.

INTRODUCTION

Radish is an annual herb hairy of thickened and tuberous roots, externally white or red round cylindrical or tapering, internal tissue is white. Radish leaves are lyrate-pinnatified up to 25cm in length with large terminal lobe (1). Radishes (*Raphanus sativus*) are a native of Europe or Asia and were being used by Egyptian at the time of Pharaohs (2). Peirce (3) reported that, radish cultivars may be grouped according to season (summer, winter and all season) and with each season by shape and colour. Several cultivars of summer type are available with resistance or tolerance to club roots (*Saxafire, Novitas*) and the globe shape desired by consumers. Winter radishes are the most successfully grown as a fall crop when short days and a cool temperature minimize bolting.

Field uniformity and radish stands are of high significance in mass production, and therefore workers pay intensive care to theses factors. Gray *et al.* (4) found that within root crop species, there is typically a two fold variation in seed or fruit weigh. In Brassica root crops, variation in seed and embryo are closely related, because the embryonic mass is a large part of the seed structure. Benjamin (5) found that variation in seedling size or mass at emergence can arise from variation is seed weight, embryonic weight, duration of pre-emergence growth and pre-emergence growth rates.Gray *et al.* (6) found that, in beet and root Brassicas there are detailed relationships between seed and embryo weights have not established.

Manipulating in plating dates to synchronize growth stages each with its favourable growth temperature is also of high benefit. Das Gupta (7) applied different temperature 15 to 25^0C to sugar beet, but in all treatment the shoot apical meristem was removed. This had three effects. First, that any signal that might be produced by this meristem was removed. Second, the sink activity would occur as some remaining leaves continued to grow. Third, the high temperature promoted senescence, which could not compensated for by the growth of new leaves, allowing for the more rapid leaf senescence at higher temperature. Radishes are easy and quick to grow, cool weather is essential for highest radish quality, since they become hot and woody in hot weather, small round varieties mature more quickly than long type (8). **The objective of this study is to improve yield and yield quality of well irrigated radish by the aid of naphthalene acetic acid.**

MATERIALS AND METHODS

A field experiments was carried out during 2005 – 2006 radishes growing season at Horticulture research field, northern Iraqi province mosul(36^0 , 42” Latitude) to investigate the possibility of improving growth, yield and yield quality of furrow cultivated black radish cultivar, irrigated when ever 25% of available water capacity is depleted to a soil depth of 25 cm by the aid of naphthalene -3- acetic acid (NAA) rates 0, 20, 30 and 40 $mg.l^{-1}$. Therefore, seeds of very popular radish cultivar namely local black radish were purchased from growers. A Randomized Complete Block Design (RCBD) was chosen for this trail to include four treatments, each was replicated five times. A furrow of 5m length and 0.8 m width was sown with 4 rows 2 on each side with plant space of 5-7cm after thinning to represent one replicate. Consequently, the experiment contained 20 furrows. Regression was made in a computer program “Minitab“, and Duncan multiple test was also used to evaluate NAA treatments.

Soil was analyzed at the Soil and Water Department Laboratory (Table, 1), while Meteorological data was obtained from Al-Rashidia Meteorological office, Mosul (Table, 2). Soil was plowed vertically and once more horizontally, then dissected to math the chosen design. A gypsum block was settled at a depth of 25cm from each furrow top to truck the fluctuations of soil moisture content caused by supplementary irrigations and rainfall incidences (9). Thus, precise time for irrigation is detected. Seeds were sown on September, 15th., 2005 with 4 rows per furrow 2 rows at the most upper third and the other 2 at the lowest third part close to the furrow bottom. Thereafter, on October, 10th., plants were thinned to a space of 5-7 cm intra plants on each row. Plants were sprayed with proposed NAA rates after the drought period and repeated after 2weeks. Irrigation was ceased for a week to harden plants and well to establish them in the soil. Weeds were manually controlled at thinning and during the growing season and Diaminophoshate (DAP) fertilizers was applied twice immediately after the drought period and again after one month at rate of 15 $g.m^{-2}$ for each application time..

Plants were harvested on February, 20th. to 25th., 2006. Plant height and leaf numbers were counted. Plant fresh weight, fresh weight of leaves and yield were measured by the aid of electrical balance. Root and leaf samples were oven-dried at 60^0C for 72 hours then weighed and dry matter percentages were calculated.

Table (1). Physical analysis for upper 30 cm Tran located silty loam soil and clayey underneath native field soil

Soil separations ($g.kg^{-1}$)	Translocated soil	Field native soil
Clay particles	564	139
Silt particles	313	564
Sand particles	123	297
Soil bulk density ($g.cm^{-3}$)	1.6	1.55
Soil field capacity (%)	21.8	20
Soil wilting point (%)	12.05	11

Table (2): Meteorological data, irrigation frequencies and applied water (mm) radish

Recorded parameters	Growing season months					
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Maximum temp. (^{0}C)	38.10	30.20	21.70	18.50	11.91	15.38
Minimum temp.(^{0}C)	19.8	13.60	7.30	6.40	3.64	6.22
Mean temp.(^{0}C)	28.95	21.90	14.50	11.95	7.60	10.80
Relative humidity (%)	34.00	65.00	57.00	67.00	78.36	71.10
Rainfall (mm)	0.0	0.0	20.60	40.20	142.70	50.80
Irrigation frequencies	1.00	6.00	3.00	3.00	0.00	2.00
Free vapor at. (mm.d^{-1})	11.5	6.19	3.39	2.1	1.14	1.79
Actual sunshine (H.d^{-1})	10.8	8.41	6.50	4.90	4.98	6.32

RESULTS AND DISCUSSION

Effect of irrigation: The results exhibited that radishes were irrigated 15 times during the growing season (figure, 1), with each irrigation soil was brought up to a field capacity to a depth of 25 cm. Therefore, the evapotranspiration of radishes raised from supplemental watering was (146.25 mm) besides that raised from rainfall source (254.3 mm). We may infer from this result that radishes required light irrigation with close intervals to ensure sufficient soil moisture throughout the effective root zone depth. Poincelot (9) reviewed that, radishes water need are 2.5cm for each 5 days and preferred soil moisture is -0.25 bar and 70% available soil moisture. Water consumptive use in vegetable crops varying with different growth stages owing to the increase in the percentage of covered soil by a crop (10).Thus, earlier stage usually is of lowest evapotranspiration then increases in consumptive use of water will continue as leaf area index continue to increase (11). Harris (12) proposed that for young crops, water extraction increased with plant density, due to the greater soil cover. Therefore, low density crops may be more susceptible than higher density crops to drought in the latter stages of crop growth

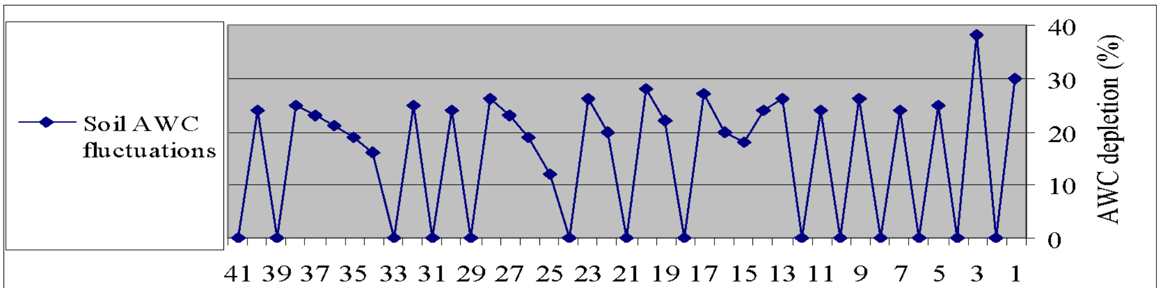


Figure (1): Irrigation frequencies for radish irrigated whenever 25% of soil AWC is depleted to a soil depth of 25 cm

Effect of NAA on fresh weight of leaves per plant:

The obtained result (table, 3) displayed that increasing the rate of sprayed NAA from 0 to 30 mg.l^{-1} resulted in leaves fresh weight increases from 85.26 to 104.9 g , respectively. However, increasing NAA rate to 40 mg.l^{-1} substantially reduced the leaves fresh weight per plant to 91.73 g. Regressional analysis (figure, 2) revealed that the relation between fresh weigh of leaves per plant and the applied NAA rates is of cubic regression type, where leaves fresh weight tends to decrease at low NAA rates and increasing NAA rates implicated gradual increases in leaves fresh weight per plant until it reaches its maximum value close to the range of 30 mgl^{-1} then the values commence to decline gradually foreword 40 $mg.l^{-1}$. This result suggests that NAA rates beyond 30 $mg.l^{-1}$ may be higher than that required for favourable leaf generation, differentiation and growth. High NAA rate tended to decrease folded and unfolded leaf numbers per plant in lettuce (13). Leaves fresh weight per plants could be estimated from the next equation: (leaves fresh weight per plant (g) = 85.2571 – 2.91623(NAA rate) + 0.246241$(\text{NAA rate})^{**2}$ - 0.0042073$(\text{NAA rate})^{**3}$)

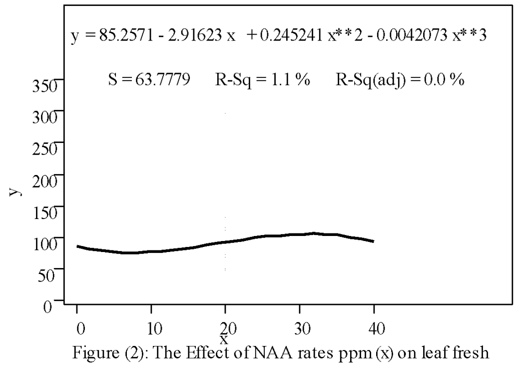
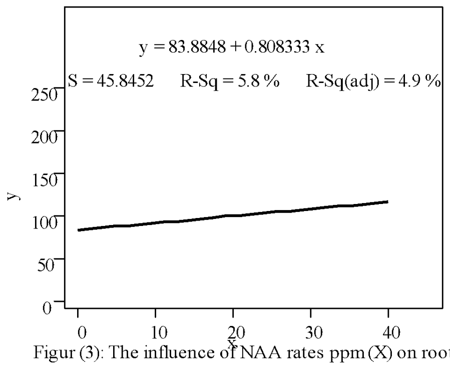


Figure (2): The Effect of NAA rates ppm (x) on leaf fresh weight (g) per plant (y) of furrow cultivated black radish

Effect of NAA on root fresh weight:

Results of individual root fresh weight (table, 3) manifested that raising the rate of sprayed NAA resulted in root fresh weight increases. Consequently 40 $mg.l^{-1}$ rate gave significantly higher root fresh weight (116.4 g) when it was compared to these observed in other treatments, particularly to check (80.93 g). Regressional results (figure, 3) showed that NAA rates are linearly correlated to individual root fresh weight and it could be predicted by the following equation: (Root fresh weight per plant (g) = 83.8848 + 0.808333(NAA rate). Responses of leaves fresh weight per plant to NAA rates is much differ than the response of root fresh weight. These responses may be explained on the basis of assimilate source sink partitioning between leaves and roots in which hormonal balance take the major role. Poincelot (9) reviewed that, although the formation of underground structure is part of vegetative development. Their modifications and reproductive structures share similar nutrient movement activities in that their development involve the translocation of nutrients and growth stimulants at the expanse of all other plant parts.



Figur (3): The influence of NAA rates ppm (X) on root fresh weight g (y) of furrow cultivated black radish

Effect of NAA on plant fresh weight: Plant fresh weight responses to NAA rates (table, 3) were substantially increased as NAA rates were raised. The highest plant fresh weights were confined to the higher last two rates (208.3 and 207.9 g, respectively). They significantly exceeded 20 mg.l^{-1} rate (191.8 g). However, the latter rate profoundly exceeded the check (160.1 g). Regression analysis showed that plant fresh weight is linearly responded to NAA rates (figure, 4). Thus estimation of plant fresh weight could be obtained from the following equation: (plant fresh weight g = 163.091 + 1.26781 (NAA rate). This improvements might be attributed to the influence of NAA on cellular membrane permeability which enhances assimilate translocation and also to the effect of NAA on the performance of xylem and phloem. Differentiation of both xylem elements and phloem sieve tubes around the wound is limited and controlled by auxins supply. This can be shown by removal of leaves (a source of auxin) above the wound, which reduces vascular regeneration. On the other hand, because auxin moves preferentially down stem, removal of leaves below the wound has little or no effect. Furthermore, the extent of vascular regeneration is directly proportional to the auxin supply when exogenous auxin is substituted for the leaves (14).

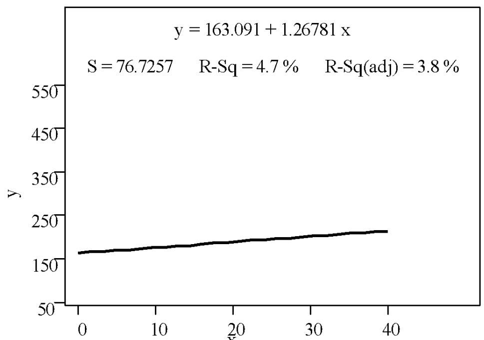


Figure (4): The influence of NAA rates ppm (x) on plant fresh weight g (y) of furrow cultivated black radish

Effect of NAA on leaf numbers per plant: Significant differences were not detected in the response of leaf numbers per plant and NAA rates (table, 3). However, a linear correlation was found regarding to the responses of leaf numbers per plant and the applied NAA rates (figure, 5), which could be estimated by the next equation: (leaf numbers per plant = 8.7122 + 0.114878(NAA rate).

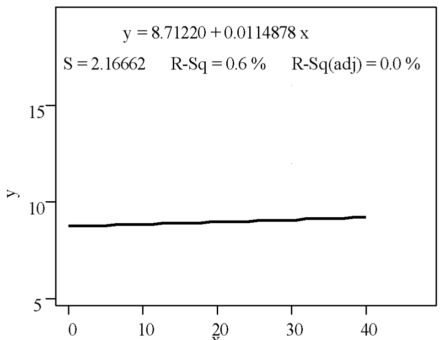


Figure (5): The influence of NAA rates ppm (x) on leaf numbers per plant (y) of furrow cultivated black radish

Effect of NAA on root: leaves ratio: The obtained results (table, 3) exhibited that gradual NAA rate increases were coincided with resemble increases in root: leaves ratio. Therefore, the highest value (1.8) was confined to 40 mg.l^{-1} NAA rate and decreases downwards were found to attain the lowest value (1.38) of untreated control. Root: leaves ratio is linearly responded to NAA rates (figure, 6). This positive correlation could be expressed by the following equation: (root: leaves ratio = 1.38588 + 0.0097226 (NAA rate)). This result suggests that NAA rate increases create more suitable conditions for root differentiation and growth on the account of leaves. This phenomenon may be accomplished through assimilate imported to roots which ease the division and expansion of root cells. Auxin facilitates the cell wall expansions by lowering the cell wall ambient environments, which loosening the glycoside bonds and linkage of the cell wall carbohydrate components. Subsequently, turgor pressure easily dissipates these components, creating new rooms for the new building materials brought from mature dictysomes, directed by microtubules to the expanding cell wall (15).

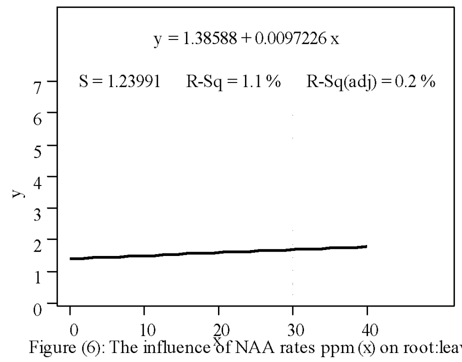
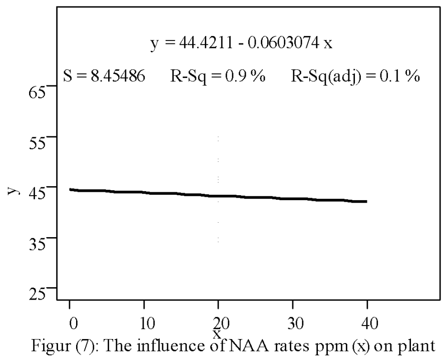


Figure (6): The influence of NAA rates ppm (x) on root:leaves ratio (y) of furrow cultivated black radish cultivar

Effect of NAA on plant height: Non- significant differences were found in plant height responses to the increasingly applied NAA rates (table, 3). However, plant height is negatively related to sprayed NAA rates (figure, 7), and estimation could be emerged from this equation (plant height cm = 44.4211 – 0.0603074(NAA rate)).



Figur (7): The influence of NAA rates ppm (x) on plant height of furrow cultivated black radish

Effect of NAA on yield: Positive radish yield responses to NAA rates were found (table, 3). Highest yield (26.64 kg.m^{-2}) was obtained from plants sprayed by 40 mg.l^{-1} rate. Non-significant difference was observed between the highest two rates. Yield reductions were matched with NAA rate reductions and the lowest yield (18.9 kg.m^{-2}) was confined to untreated check. Positive linear correlation was found in yield responses to the applied NAA rates (figure, 8).

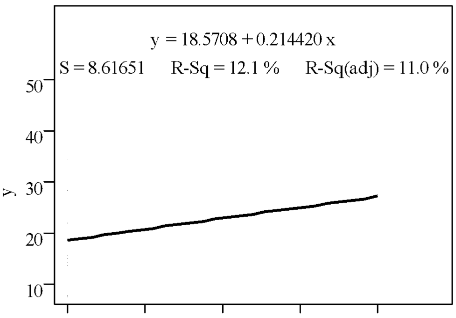


Figure (8): The influence of NAA rates ppm (x) on yield kg.m-2 (y) of furrow cultivated black radish cultivar

Effect of NAA on dry matter accumulation in leaves: Non- significant differences were found in dry matter accumulation in leaves responses to the increasingly applied NAA rates (table, 3). Regression analysis (figure, 9) revealed that dry matter percentage of leaves responses to NAA rates could be estimated from cubic regression type equation (dry matter percentage of leaves (%) = 10.15 + 0.46125(NAA rate) – 0.0303125(NAA rate)^{**2} + 0.0004813(NAA rate)^{**3}). This equation point out that the maximum dry matter percentage could be achieved at 10 mg.l^{-1} rate, rates beyond this NAA rate tends to reduce the accumulation of dry matter in leaves to its lowest value at 33 mg.l^{-1}, then the values start to increase to nearly 10% at 40 mg.l-1 rate.

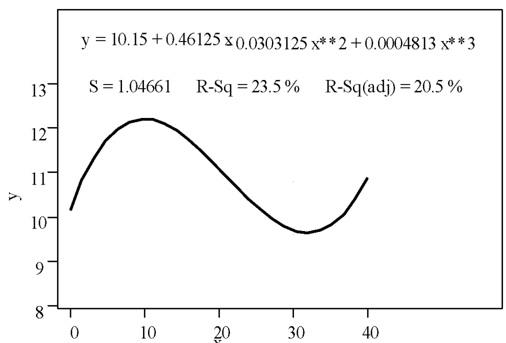


Figure (9): The influence of NAA rates ppm (x) on leaf dry matter percentage of furrow cultivated black radish

Effect of NAA on root diameter: Non-significant differences were observed in the responses of root diameter to NAA rates (table, 3). Whereas, regression analysis (figure, 10) revealed that root diameter could be estimated from quadratic regression equation (root diameter (cm) = 5.57894 – 0.0184913(NAA rate) + 0.000443(NAA rate$^{)**2}$)).

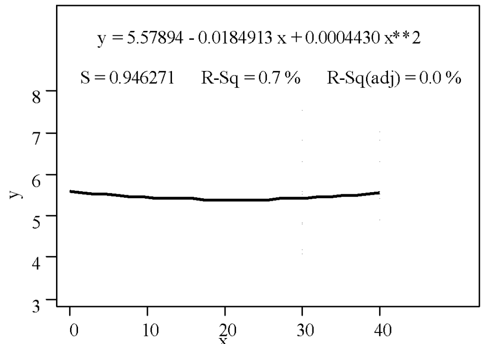


Figure (10): The influence of NAA rates ppm (x) on root diameter cm (y) of furrow cultivated black radish cultivar

Effect of NAA on dry matter accumulation in root: Non-significant differences were observed in the responses of root dry matter percentage to NAA rates (table, 3). Whereas, regression analysis (figure, 11) revealed that root diameter could be estimated from quadratic regression equation (root dry matter percentage = 7.32409 + 00.121795(NAA rate) - 0.0032614(NAA rate)^{**2})).

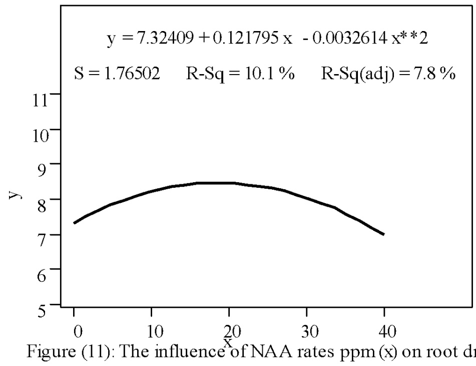


Figure (11): The influence of NAA rates ppm (x) on root dry matter percentage (y) of furrow cultivated black radish

Table (3): The influence of NAA rates on furrow cultivated black radish cultivar

NAA Rates $mg.l^{-1}$	leaves fresh wt g	Root fresh wt g	Plant fresh wt g	Leaves per plant	Root: Leaves Ratio	Plant height cm	Radish yield $kg.m^{-2}$	leaf dry matter (%)	root dia. (cm)	Root DM (%)
0	85.26c	80.93c	160.1c	8.65a	1.38b	44.54a	18.9c	10.15a	5.1a	7.23a
20	89.1bc	106.2b	191.8b	9.06a	1.6ab	43.22a	23.55b	11.1a	5.38a	9.05a
30	104.9a	102.9b	208.3a	9.00a	1.62ab	42.25a	25.17a	9.7a	5.33a	7.25a
40	91.73b	116.4a	207.9a	9.15a	1.80a	42.32a	26.64a	10.9a	5.58a	7.28a
means	92.75	101.61	192.03	8.97	1.6	43.08	23.57	10.46	5.35	7.70

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