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INTEGRATED EFFECTS OF NITROGEN, MULCH AND GIBBERELLIC ACID ON MULTI-PURPOSE PUMPKIN (*Cucurbita moschata* Duch.) FRUIT AND SEED YIELDS

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ABSTRACT
Pumpkin (*Cucurbita moschata* Duch.) potentially is a dependable source of household income, food and nutrition security. However, unpredictable productivity is a challenge most farmers face since pumpkin is considered a resource-poor and low status crop, and is underutilized in some parts of the world. There is a need for its popularization and productivity enhancement through integrated input management. Understanding the combined effects of nitrogen, mulch and gibberellic acid (GA_3) on yield is important in maximizing economic value. Subsequently, a split-split block experiment in randomized complete block design and replicated three times was conducted from January 2019 to July 2020. The main plots were assigned to nitrogen (CAN) at 0, 50, 100 and 150 kg N/ha, split plots to mulch (none, black-painted and unpainted rice straws), while sub-plots to GA_3 at 0, 40 and 80 mg/L. Experimental plants were established by sowing two seeds per hole spaced at 2m x 2m, and seedlings thinned to one per hole post-germination. Nitrogen was applied in two equal doses at 3-weeks post-emergence and at the beginning of flowering. Mulches were placed on plots after land preparation. The GA_3 was sprayed once after 4-weeks post-emergence. Data was collected fortnightly from 4-weeks post-emergence and subjected to analysis of variance using SAS software version 9.3. Means were separated using least significant difference test at α=0.05. Nitrogen and mulch effects depended on season. Nitrogen had a significant (P<0.05) effect on total fruit weight in S1, and on number of seeds in both seasons. The 150 kg N/ha yielded highest fruits (3.7, 5.6), total fruit weight (11.3, 17.6) and seeds (603.9, 575.7) in S1 and S2, respectively. Black-painted mulch produced significantly (P<0.05) higher fruits and total fruit weight in S1, compared to the brown-painted mulch and control. The GA_3 had no significant (P>0.05) effect during both seasons and hence its use may not directly enhance yields. The present study recommends use of 150 kg N/ha and black-painted mulch to optimize pumpkin yields.

KEYWORDS: *Cucurbit*s, Flower set, Fruit set, Plant growth regulators, Neglected and under-utilized species, Parthenocarpy

INTRODUCTION
Multipurpose pumpkin (*Cucurbita moschata* Duch.) is an emerging high value fruit-vegetable, providing households producing it with income and various diets that contribute to food and nutrition security. Multipurpose pumpkin leaves, fruits and seeds are edible and their nutritional value is high. Pumpkin fruits contain biologically active components with distinguishable dietary qualities (Jukneviciene et al., 2013). Pumpkins contain a lot of minerals, vitamins, particularly vitamin A provitamin β-carotene, ascorbic acid, B1, B2, B6 and E. They are rich in carbohydrates. Sugars in pumpkins average 5% to 6%, depending on climatic conditions. Pumpkins have low calorific value, fluctuating from 15 to 39 kcal (Murkovic et al., 2004). The nutritional value of pumpkin seeds is due to high protein content (25-51%) and oil (40-60%) (Abdel-Rahman, 2006). The oil contains the fatty acids, namely 25-35.9% oleic and 40.4-55.6% linoleic acid, 5.2-7.5% stearic and 6.2-12.4% palmitic acids (Applequist et al., 2006). Pumpkins contain medicinal raw materials that are used for production of pharmaceutical products like peponen and pepostrin used in overcoming prostatic hypertrophy and urinary tract irritation (Sedghi et al., 2008). The seeds have shown good results in therapy of minor disorders of the prostate gland and the urinary bladder (Pericin et al., 2008).

Nitrogen is the most commonly required fertilizer during pumpkin production although phosphorous is needed to promote good seedling vigour, maximum production and high fruit quality (Mahfouz and sharaf-eldin, 2007). Nitrogen is commonly applied in two side-dressings, the first at the 2-4 leaf stage and the second when vines start to develop runners. The goal is to grow plants with a large canopy of leaves, maintaining healthy leaves as long as possible. This can be done by maintaining adequate levels of fertilizer, taking care not to over-fertilize the crop with nitrogen (Efthimiadou et al., 2010). Excessive N favours vegetative growth over reproductive growth and can inhibit fruit set. Nitrogen rate must be low enough by the time flowering starts so that the plant will form fewer new leaves after fruits begin to grow to allow more sugars to go to the fruits, rather than to developing leaves and vines (Min-gang, 2008).

Mulches, and particularly the clear form, have been reported to enhance germination of directly seeded pumpkin since they increase soil temperatures (Fang et al., 2007). Mulching is one of the ways used to better domesticate soil and to increase crop yield. Mulch has been found to reduce evaporation of moisture, regulate soil temperature, improve soil structure, organic matter stocks and plant nutrition (Wyenandt et al., 2008; Splawski, 2012). Fang et al. (2007) reported that as a result of mulching with grass over 55% of the available nitrogen was released into the soil during the first 4 months of application during pumpkin production.

According to Yamaguch and Kamiya (2000), gibberellic acid (GA_3) hormone plays an essential role in many aspects of plant growth and development of pumpkins such as seed germination, stem elongation and flower development. Gibberellic acid is an important plant growth regulator that affects plant growth and development by inducing metabolic activities and regulating nitrogen utilization (Sure et al., 2012). It also plays a significant role in seed germination, endosperm mobilization, stem elongation, leaf expansion, reducing maturation time and increasing flower and fruit set and their composition (Roy and Nasiruddin, 2011). Gibberellic acid delays senescence, improves growth and development of chloroplasts, and intensifies photosynthetic efficiency which could lead to increased yields (Yuan and Xu, 2001). The present study determined the individual and combined effect of nitrogen, mulch and GA_3 on the number of fruits, total fruit weight and number of seeds of multi-purpose pumpkins.

MATERIALS AND METHODS

Site and Experiment

The experiment was conducted at Chuka University farm located at 0^0 19' S, 37^o 38' E and 1535 m above sea level. The average annual temperature is 19.5 ºC, ranging from 12.2ºC to 23.2ºC. The area experiences the long rains in March through June and the short rains from October to December. The average annual rainfall is 1200 mm (http://en.climate-data.org). It has humic Nitisols, deep, strongly weathered, well drained tropical soils with a clayey subsurface horizon made of angular, blocky structural elements that easily crumble into polyhedricipeds with shiny surfaces. The soil has a high cation exchange capacity (Koskey et al., 2017).

A three factor split-split block experiment embedded in a randomized complete block design with three replications was used. Individual plots in a block measured 2 m x 2 m and were separated from each other by 1 m. The three factors were nitrogen, mulch and gibberellic acid (GA_3). Nitrogen was assigned to the main plots, mulch to split plots and GA_3 to subplots. The four nitrogen (CAN) rates were 0, 50, 100 and 150 kg/ha. Nitrogen was split into two equal doses for each rate, and applied at 3-weeks post-emergence and at the beginning of flowering. Mulch types were no mulch, black-painted rice straw and unpainted rice straw. The black-painted dry rice straw and unpainted dry rice straw was placed on the respective split plots after land preparation. Painting of the rice straw was done by dipping them in a 200 L drum containing black paint solution and afterwards spread out to air-dry. The ingredients of the paint were noted based on the paint that was used. The mulch was uniformly spread to achieve 20 cm thickness. Planting holes were marked and opened during seed sowing.

Gibberellic acid rates were 0, 40 and 80 mg/L. Gibberellic acid was dissolved in 50 ml alcohol and then the volume made up to 1 L stock solution by adding distilled water. The required concentration of spray solution was then prepared from stock solution by diluting with distilled water. A few drops of commercial sticker were added to facilitate uptake into leaves. The GA_3 solution was sprayed to the plants using a 1 L hand-held sprayer. Stock solution of lower rate was sprayed first followed by next higher rate. Spraying was done once during the fourth week after emergence. To avoid drift, spraying was done in the morning. Soil analysis was done at the KALRO National Agricultural Laboratories at Kabete before plant establishment. The soil was sampled using a zigzag sampling design across the experimental field and two composite samples prepared for topsoil (0-15 cm) and subsoil (16-30 cm). The soil pH, total N, available P, K, Ca, Mg, organic carbon, and trace elements were assessed (Chang and Laird, 2002).

Data values were collected for two seasons, long rains season 1 (S1) and short rain season 2 (S2). Fruits with dry fruit stalk and hard skin were harvested from each experimental unit, counted and weight. Three fruits randomly selected per treatment were used to take data on the number of seeds. Seeds were counted and the number per treatment recorded. Data values were subjected to analysis of variance to determine effects of the treatments using the SAS software version 9.3. Means were separated using the least significant difference (LSD) test at α = 0.05.

RESULTS

Effect of Nitrogen on Fruit and Seed Yields

Nitrogen had no significant (P>0.05) effect on the number of fruits during both seasons (Table 1). Application of 150 kg N/ha had the highest number of fruits, 3.7 and 5.6, during S1 and S2, respectively. In both seasons, the number of fruits increased with increase in N up to 150 kg N/ha. There was a 24.7% to 36.7% increase in the number of fruits during S2, compared to S1. The control had the lowest number of fruits, 3.1 and 4.1 during S1 and S2, respectively.

Nitrogen had a significant (P<0.05) effect on total fruit weight during S1 only. The 150 kg N/ha produced the highest total fruit weight in seasons 1 and 2, 11.3 kg and 17.6 kg, respectively (Table 1). Total fruit weight increased with increase in N up to 150 kg/ha during both seasons. The increase in the total fruit weight ranged from 53.1% to 58.1% in S2 compared to S1. The control treatment had 5.1 kg and 12.2 kg total fruit weight in S1 and S2, respectively. Nitrogen had a significant (P<0.05) effect on the number of seeds during both seasons. Application of 150 kg N/ha produced the highest number of seeds of 604 during S1. Seeds increased with increase in N up to 150 kg N/ha during S1.

Effect of Mulch on Fruit and Seed Yields

Mulch had a significant (P<0.05) effect on number and weight of fruits in S1 (Table 2). The effect of mulch on seeds was not significant (P>0.05) during both seasons. Highest number of fruits was produced when black-painted rice straw mulch was applied, 4.53 and 5.17 in S1 and S2, respectively. When black-painted rice straw mulch was applied, total fruit weight was higher compared to when unpainted rice straw mulch or no mulch was applied. The same was the case in the number of seeds with 570 and 547.4 in S1 and S2, respectively.

Effect of Gibberellic Acid on Fruit and Seed Yields

Gibberellic acid had no significant effect on the number of fruits, total fruit weight and the number of seeds during both seasons (P>0.05) (Table 3). The best GA_3 rate for the three yield parameters depended on the season and had no consistent trend.

Effect of Nitrogen, Mulch and GA_3 on Fruit and Seed Yields

Results for the combined effect of N, mulch and GA_3 on fruits, total fruit weight and number of seeds were not significantly ($P>0.05$) different in both seasons (Table 4). The best result for the three factors depended on the season and had no consistent trend.

TABLE 1: Effects of nitrogen on fruit and seed yields

Nitrogen rate (kg/ha)	Number of fruits		Total fruit weight (kg)		Number of seeds	
	S1	**S2**	**S1**	**S2**	**S1**	**S2**
Control	3.07	4.11	5.12d	12.21	464.8b	480.3b
50	3.37	4.48	6.30bc	13.42	540.4a	466.8b
100	3.40	5.37	7.56b	16.81	579.2a	571.3a
150	3.70	5.63	11.28a	17.61	603.9a	575.7a
P-value	0.908	0.408	0.013*	0.296	0.009*	0.004*
$LSD_{0.05}$	2.118	2.237	3.744	7.243	66.1	54.25

TABLE 2: Effects of mulch on fruit and seed yields

Mulch type	Number of fruits		Total fruit weight (kg)		Number of seeds	
	S1	**S2**	**S1**	**S2**	**S1**	**S2**
Control	2.36c	4.58	5.43b	13.41	536	502.5
Black-painted mulch	4.53a	5.17	8.81a	16.37	570	547.4
Brown mulch	3.25b	4.94	8.44a	15.27	534	520.7
P-value	0.004*	0.601	0.044*	0.251	0.313	0.621
$LSD_{0.05}$	1.161	1.217	2.837	3.635	54.5	47.12

TABLE 3: Effects of gibberellic acid on fruit and seed yields

GA3 rate (mg/L)	Number of fruits		Total fruit weight (kg)		Number of seeds	
	S1	**S2**	**S1**	**S2**	**S1**	**S2**
Control	3.14	5.58	7.54	16.53	561	518.4
40	3.44	4.53	7.53	13.68	524	516.2
80	3.56	4.58	7.61	14.83	556	536.0
P-value	0.804	0.082	0.997	0.252	0.313	0.498
$LSD_{0.05}$	1.310	1.040	2.356	3.428	52.1	36.62

DISCUSSION

The present study showed that the number of fruits, total fruit weight, and number of seeds were enhanced by nitrogen during the two seasons. The increase was attributed to the fact that plants during flowering and fruit setting stages need a high amount of N and other nutrients to perform the biological activities. Nitrogen increases photosynthesis coupled with chlorophyll synthesis (Ding et al., 2006). The dependence of fruit weight on fertility and season in Cucurbits had been reported earlier by Oloyede and Adebooye (2005). The optimum nitrogen rate in the present study was 150 kg/ha, as evidenced by the highest number of fruits, total fruit weight, and number of seeds produced.

Ramakrishna et al. (2006) reported that evaporation from the soil accounts for 25-50% of the total quantity of water used. In the present study, black-painted rice straw mulch produced positive effect on the number of fruits, total fruit weight and number of seeds, as compared to unpainted rice straw mulch and no mulch. The results agreed with those of Mahadeen (2014) who found that okra and squash fruit number and weight were increased by back plastic mulch. Number of fruits and total fruit weight are products of vegetative growth improvement when mulch improves moisture conservation and availability (Ban et al., 2009; Mamkagh, 2009). Earlier researchers reported that yield parameters improvement due to increased vegetative growth after using mulch might be due to enhancement of photosynthesis and other metabolic activities in plants (Bhatt et al., 2011; Parmar et al., 2013).

Application of 40 mg/L to 80 mg/L GA_3 increased the number of fruits, total fruit weight, and number of seeds. Gibberellic acid has been found to promote growth and elongation of cells which would explain the increase in the yield parameters in the present study (Sure et al., 2012; Roy and Nasiruddin, 2011; Yuan and Xu, 2001). The present findings agreed with those of Kazemi (2014) and Majumdar (2013), which revealed an increase in fruit weight and number of fruits of tomato and cabbage treated with GA_3. The combined effect of N, mulch and GA_3 on the number of fruits, total fruit weight, and number of seeds was not significant during both seasons probably because the effects of the three factors moderated the beneficial effects of each other, leading to no treatment emerging to be significantly superior than the other.

TABLE 4: Effect of nitrogen, mulch and GA_3 on fruit and seed yields

Treatment	Number of fruits		Total fruit weight (kg)		Number of seeds	
	S1	**S2**	**S1**	**S2**	**S1**	**S2**
$N_0M_0GA_0$	2.3	4.3	2.0	10.7	558	474
$N_0M_1GA_0$	3.0	4.0	5.8	11.8	552	517
$N_0M_2GA_0$	1.3	4.7	3.5	11.7	403	460
$N_0M_0GA_1$	2.7	3.7	3.9	11.8	437	506
$N_0M_1GA_1$	4.0	6.7	8.3	20.5	496	474
$N_0M_2GA_1$	2.3	1.7	3.0	3.7	408	435
$N_0M_0GA_2$	1.7	2.7	2.7	8.3	416	506
$N_0M_1GA_2$	10.7	4.3	5.7	14.3	474	468
$N_0M_2GA_2$	5.3	5.0	11.2	17.2	437	483
$N_1M_0GA_0$	1.3	5.3	2.5	18.8	541	524
$N_1M_1GA_0$	5.0	4.7	10.2	13.0	652	463
$N_1M_2GA_0$	4.3	4.3	11.7	13.7	504	428
$N_1M_0GA_1$	2.3	2.7	3.0	7.8	465	425
$N_1M_1GA_1$	5.0	4.0	8.5	17.0	588	494
$N_1M_2GA_1$	1.7	5.0	4.5	15.5	480	498
$N_1M_0GA_2$	0.7	4.0	1.3	10.3	536	409
$N_1M_1GA_2$	3.3	5.0	6.2	13.5	592	499
$N_1M_2GA_2$	4.0	5.3	8.8	16.2	506	463
$N_2M_0GA_0$	1.7	6.0	2.2	16.0	549	517
$N_2M_1GA_0$	4.0	8.0	11.3	26.2	656	622
$N_2M_2GA_0$	5.7	5.0	11.8	17.3	626	565
$N_2M_0GA_1$	3.7	6.3	8.8	19.3	633	569
$N_2M_1GA_1$	5.0	4.3	8.7	12.0	514	562
$N_2M_2GA_1$	3.7	3.3	5.5	10.2	627	568
$N_2M_0GA_2$	2.7	4.7	9.0	16.3	582	554
$N_2M_1GA_2$	3.0	6.0	6.8	19.0	506	599
$N_2M_2GA_2$	1.0	4.7	3.8	15.0	519	585
$N_3M_0GA_0$	3.7	5.3	8.3	15.5	571	485
$N_3M_1GA_0$	3.0	8.0	9.5	26.3	560	624
$N_3M_2GA_0$	3.3	7.3	11.7	22.5	588	542
$N_3M_0GA_1$	3.7	5.0	10.3	13.8	543	491
$N_3M_1GA_1$	4.7	4.7	14.8	15.8	518	576
$N_3M_2GA_1$	2.7	7.0	11.0	16.7	580	596
$N_3M_0GA_2$	3.0	5.0	11.2	17.2	606	570
$N_3M_1GA_2$	3.7	2.3	9.8	7.0	738	671
$N_3M_2GA_2$	3.7	6.0	14.8	23.7	762	626
P-value	0.493	0.251	0.660	0.214	0.811	0.770
$LSD_{0.05}$	4.441	3.974	8.491	12.643	176.9	133.333

S1- Season 1, **S2-** Season 2

CONCLUSIONS AND RECOMMENDATIONS

The results have proved that increasing nitrogen and mulch significantly improve the total fruit weight and number of seeds in multi-purpose pumpkins. The effect of GA_3 may not be directly impact reproductive components, including fruit number, fruit weight and seed number, but may act through impacting vegetative growth parameters. Combined nitrogen, mulch and GA_3 consistently do not significantly affect the number of fruits, total fruit weight, and number of seeds in multipurpose pumpkin, and hence it is the individual effects of the three factors that are important. Since application of 150 kg N/ha produced the highest results, the present study recommends its use to optimize yields. The study also recommends use of black-painted rice straw mulch to cover soil to enhance yields of multi-purpose pumpkin.

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REFERENCES

Abdel-Rahman, M.K. (2006) Effect of pumpkin seed (*Cucurbita pepo* L.) diets on benign Prostatic hyperplasia (BPH) chemical and morphometric evaluation in rats. *World Journal of Chemistry*, **1**, 33-40.

Applequist, W.L., Avula, B, Schaneberg, B.T., Wang, Y. H. and Khan, I.A. (2006) Comparative fatty acid content of seeds of four *Cucurbita* species grown in a common (shared) garden. *Journal of Food and Comparative Analysis*, **19**; 606-611.

Ban, D., Zanic, K., Dumicic, G., Culjak, T.G. and Ban, S.G. (2009) Type of polyethylene mulch impacts vegetative growth, yield and aphid populations in watermelon production. *J. Food Agric. Environ.*, 7, 543-550.

Bhatt, L., Rana, R., Uniyal, S.P. and Singh, V.P. (2011) Effect of mulch materials on vegetative characters, yield and economics of summer squash (*Cucurbita pepo*) under rainfed mid-hill condition of Uttarakhand. *Veg. Sci.,* **38**, 165-168.

Chang, C.W. and Laird, D.A. (2002) Near-infrared reflectance spectroscopy analysis of soil C and N. *Soil Science,* **167**(2), 110-116.

Efthimiadou, A, Bilalis, D, Karkanis, A., and Froud-Williams, B. (2010) Combined organic/inorganic fertilization enhance soil quality and increased yield, photosynthesis and sustainability of sweet maize crop. *Australian Journal of Crop Science*, **4**(9), 722-729.

Fang, S., Xie B. and Zhang, H. (2007) Nitrogen dynamics and mineralization in degraded agricultural soil mulched with fresh grass. Plant Soil, **300**, 269-280.

Jukneviciene, E., Cerniauskiene, J., Kulaitiene, J. and Jukneviciene, Z. (2013) Oil pumpkins-important source of antioxidants. *Journal of Food, Agriculture and Environment*, **11**(1), 132–134.

Kazemi, M. (2014) Effect of gibberellic acid and potassium nitrate spray on vegetative growth and reproductive characteristics of tomato. *Journal of Biological and Environmental Science,* **8**, 1-9.

Koskey, G., Mburu, S.W., Njeru, E.M., Kimiti J.M., Ombori, O. and Maingi, J.M. (2017) Potential of native rhizobia in enhancing nitrogen fixation and yields of climbing beans (*Phaseolus vulgaris* L.) in contrasting environments of Eastern Kenya. *Front. Plant Sci.***,** **8**, 443.doi: 10.3389/fpls.2017.

Mahadeen, A. (2014) Effect of polyethylene black plastic mulch on growth and yield of two summer vegetable crops under rain-fed conditions under semi-arid region conditions. *American Journal of Agricultural and Biological Science,* **9**(2), 202-207.

Mahfouz, S.A. and Sharaf-Eldin, M.A. (2007) Effect of mineral vs. biofertilizer on growth, yield, and essential oil content of fennel (*Foeniculum vulgare* Mill.). *International Journal of Agrophysics*, **21**, 361-366.

Majumdar, F. (2013) Response of gibberellic acid and pot-ash nutrient on growth and yield of late planting cabbage. MSc thesis, Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh, pp. 62-84.

Mamkagh, A.M.A. (2009) Effect of tillage time and black plastic mulch on growth and yield of okra (*Abelmoschus esculentus*) grown under rain-fed conditions. *Int. J. Agric. Biol.,* **11**, 453-457.

Min-gang, X., Dong-chu, L., Jumei, L., Dao-zhu, Q., Yagi, K. and Hosen, Y. (2008) Effect of organic manure application with chemical fertilizers on nutrient absorption and yield of rice in Huwan Southern China. *China Journal of Agricultural Sciences,* **7**(10), 1245-1252.

Murkovic, M., Piironen, V., Lampi, A.M., Kraushoffer, T. and Sontag, G. (2004) Changes in chemical composition of pumpkin seeds during the roasting process for production of pumpkin seed oil. *Food Chemistry,* **84**, 359–365.

Oloyede, F.M. and Adebooye, O.C. (2005) Effect of season on growth, fruit yield and nutrient profile of two landraces of *Tricosanthes cucumerina* L. *African Journal of Biotechnology*, **4**(6), 1040-1044.

Parmar, H.N., Polara, N.D. and Viradiya, R.R. (2013) Effect of mulching material on growth, yield and quality of watermelon (*Citrullus lanatus* Thunb) Cv. Kiran. *Univ. J. Agric. Res.,* **1**, 30-37.

Pericin, D., Radulovic, L., Trivic, S. and Dimic, E. (2008) Evaluation of solubility of pumpkin seed globulins by response surface method. *Journal of Food Engineering,* **84**, 591-594.

Ramakrishna, A., Hoang, M.T., Suhas, P.W. and Tranh, D.L. (2006) Effect of mulch on soil temperature, moisture, weed infestation and yield of groundnut in northern Vietnam. Field Crops Res., **95**, 115-125.

Roy, R. and Nasiruddin, K.M. (2011) Effect of different level of GA_3 on growth and yield of cabbage. *Journal of Environmental Science and Natural Resources*, **4**, 79-82.

Sedghi, M., Gholipouri, A. and Sharifi, R.S. (2008) γ-Tocopherol accumulation and floral differentiation of medicinal pumpkin (*Cucurbita pepo* L.) in response to plant growth regulators. *Not. Bot. Hort. Agrobot. Cluj.,* **36(**1), 80-84.

Splawski, C.E. (2012) Mulch Effects on Squash (*Cucurbita pepo* L.) and Pollinator (*Peponapis pruinosa* Say.) Performance. Master thesis. The Ohio State University, Columbus, p. 34.

Sure, S., Arooie H. and Azizi, M. (2012) Influence of plant growth regulators (PGRs) and planting method on growth and yield in oil pumpkin (*Cucurbita pepo* var. styriaca). *Notulae Scientia Biologicae*, **4**(2), 101-107.

Wyenandt, C.A., Heckman, J. R. and Maxwell, N.L. (2008) Fusarium fruit rot (*Fusarium* spp.) of pumpkin (*Cucurbita pepo*) and its control with cover crop mulches. *HortTechnology,* **18**(3), 361-364.

Yamaguch, S. and Kamiya, Y. (2000) Gibberellin biosynthesis: It's regulation by endogenous and environmental signals. *Plant Cell Physiology*, **41**(3), 251-257.

Yuan, L. and Xu, D.Q. (2001) Stimulation effect of gibberellic acid short-term treatment on the photosynthesis related to the increase in Rubisco content in broad bean and soybean. *Photosynthesis Research,* **68**, 39-47.